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END RESULTS OF ARTERIAL TRANSPLANTS

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IN recent years much interest has been taken in the surgery of blood-vessels, and since the revival of the work by Carrel and Guthrie [1] in 1905, many new fields for the application of the procedure have been suggested. In the early endeavors, the repair of wounds of arteries, such as might be received in battle or accidents, appeared to be the extent to which the limited technic would permit interference with the arterial walls. Carrel and Guthrie were, however, able to perfect a technic which permitted the more extensive invasion of the field of surgery of the arteries, and which to-day opens up possibilities which would previously not have been attempted. Subsequently they applied their technic, demonstrating the variety of ways in which arterial and venous circulation could be reëstablished, and the ability of the various types of vascular tissue, even under extremely unnatural conditions, to serve adequately for the permanent restitution of arteries and veins. Naturally, this work was all performed on animals before any attempt was made to apply it to man. Their results demonstrated, and they have been abundantly confirmed by others, that repair is a practical undertaking, either by means of a simple suture of the injured walls or by the employment of patches or segments of vascular or other tissue. For example, a vessel from which a portion of the wall has been removed can be repaired by a tissue such as peritoneum, or a segment of a vessel can be removed and the vascular channel restored permanently by introducing a segment of artery or vein either from the same or a different species of animal, in either the fresh (or surviving) or dead condition. Examples of the latter are segments of formaldehyde preserved tissue or tissues preserved by refrigeration.

In repairing an injured or diseased artery by implanting a segment of another vessel, we are confronted by a problem of three aspects. Firstly, a technic which will permit handling the vessel wall without developing secondary results as hemorrhage or thrombosis; secondly, reëstablishment of an adequate circulation through the segment interposed between the cut ends of the artery; thirdly, the implanted segment must continue to carry

on the circulatory function of the original segment regardless of the changes which may affect its tissues. It is in connection with the last part of the problem that our present interest mainly lies. The technic of the operation on experimental animals is well established, and when properly mastered does not often fail to give satisfactory results. Occluding thrombosis is infrequent. Naturally the results obtained in experimental animals yield a greater percentage of successful results than can be hoped for from similar operations carried out upon diseased vascular tissues in man.

Respecting the second point, we have come to learn that a great variety of tubular structures can serve as a conduit for short distances, and that although the inserted conduit does not possess the elasticity nor the factors for the regulation of the blood flow, this becomes a minor point when the major problem, the restitution of the circulation, is taken into account. Thus, to permit an adequate amount of blood to reach a given organ, like the kidney, it is necessary to insert a tube of sufficient calibre between the separated ends of the renal artery. A glass tube, or a silver or gold tube can be made to serve quite adequately to restore the circulation. But with tubes of this kind the permanency of the operation will remain in doubt, inasmuch as such hard inorganic tubes can never become welded with the living tissues, and although an inflammatory tissue will surround these tubes and hold them in position, there is always danger that the adaptation of the tube to the tissue will become loosened and secondary hemorrhage result. Moreover, metal tubes tend, sooner or later, to encourage thrombosis, even though their surfaces have received special treatment before insertion.

The operative features of the excision of a segment of artery and its substitution by another tubular structure of some kind having been demonstrated as feasible, the important issue in the problem was the determination of the best structure which could not only serve as a temporary conduit, but which would also give a permanency to the undertaking. For this purpose living segments of arteries from the same animal or from other animals of the same species were used; later it was found that segments of living veins could be employed in restoring the circulatory continuity of a divided artery or vein. Finally, however, it was shown that in such implantation of living hetero-vascular segments, few if any cells of the implanted portion survived, yet good functional results were obtained.[2] It was then found that satisfactory results could be obtained by inserting a devitalized segment of an artery or a vein.[3] Such tubes could be prepared at leisure, preserved in a formaldehyde solution, and, when required, the appropriate length could be cut from the preserved tissue and after removal of the formaldehyde and impregnation with oil or vaseline, could be interposed between the ends of the cut artery.

The question, however, arises as to the final outcome of these introduced tubes; how long can they serve as vascular conduits; and are there any secondary conditions arising in the inserted segment which may eventually destroy their function?

The reports by various authors upon the value of vascular transplantation in surgery have usually been made upon experimental investigations, in which

the experimental animal was kept under observation for a period of a few weeks or a few months. Carrel reports observations upon one dog in which

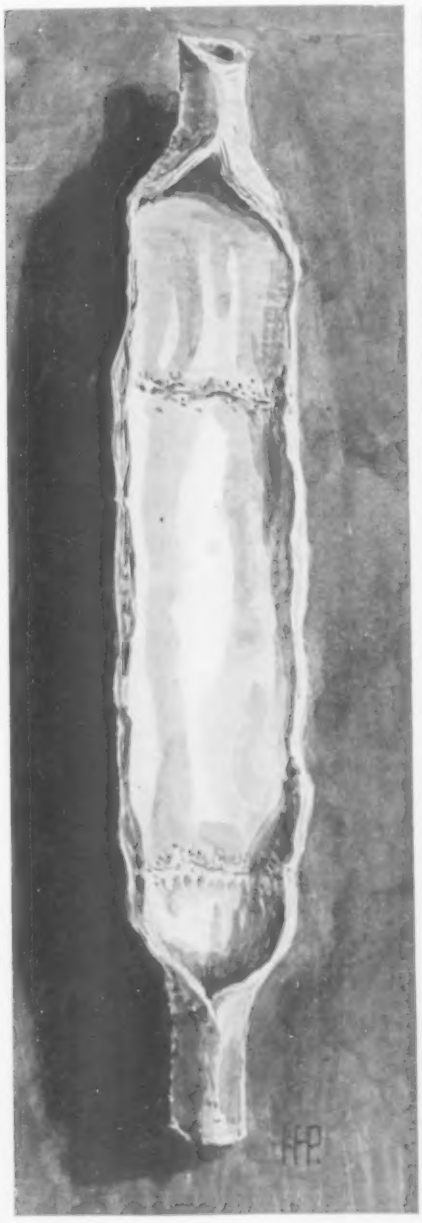

FIG. 1.—Auto-transplantation. Dog. Common carotid artery on common carotid artery. Twenty-eight days.

FIG. 2.—Auto-transplantation. Dog. External jugular vein on common carotid artery. Twenty-eight days.

the interposed segment functionated for four years.[4] Watts [5] carried out his observations after twenty-six days, Fischer and Schmieden [6] after 86 days and Levin and Larkin [7] 11 days after the operation. In general the

results of the various authors agree that it is not very important which kind of vessel is used to reëstablish continuity of a divided vessel, granted that the calibre is adequate for the circulation.

AUTO-TRANSPLANTATION

A. *Artery on Artery* (Fig. 1).—If a segment of an artery be removed and promptly replaced by suturing so as to reëstablish the continuity of the vessel, the results are excellent, not only from the functional, but from both the morphological and histological standpoints. After a few weeks, morphologically the implanted segment can scarcely be identified, and histologically the structure is essentially the same as the unengrafted parts of the vessel.[8]

B. *Vein on Artery* (Fig. 2).—A segment of vein similarly engrafted on an artery shows a moderated enlargement, with thickening of the wall through fibrosis, and disappearance of muscular tissue. Apparently the fibrous thickening of the wall proceeds to a point where the tendency of the segment to dilate is overcome, and the two processes become stabilized. Good permanent functional results are obtained.[9]

An analysis of the end results in two cases of transplantation of vascular segments is here given. They illustrate the similarity of the functional results regardless whether living heterologous tissue is used in transplantation or whether devitalized vascular segments are used.

HETERO-TRANSPLANTATION

Rabbit aorta on carotid artery of dog.—(Fig. 3).—In 1907, one of us (Guthrie)[10] carried out a successful experiment in which a segment of rabbit's aorta was interposed between the ends of a divided carotid artery of a dog. This experiment was performed on May 15, 1907, a young dog with a fairly marked goitre being used. A short segment 0.5 cm. long was excised from the left common carotid and a segment of the abdominal aorta of a rabbit was implanted. At the time of the operation it was noted that the rabbit aorta was considerably smaller both as to the size of the lumen, the total diameter and the thickness of the walls than the dog's carotid. The rabbit aorta was obtained from an animal which had just been killed. On the completion of the operation the circulation was quickly restored. One month later (June 15, 1907) the site of operation was again reopened and the implanted segment was found to have dilated so that it was now of equal size to the common carotid to which it was joined. The segment also appeared longer than when transplanted. The circulation through it was good. On December 15, 1907, the segment and the neighboring portions of the carotid artery were removed. At the time of this operation, the circulation through the implanted segment was good. It was found, however, that the segment was still larger than when previously examined. It had dilated so that the interposed rabbit aorta was of greater diameter than the carotid of the dog. Furthermore, the segment was longer and while lying *in situ* was more rigid than the arterial tissues to which it was attached. The lumen was patent and there was no thrombosis. After the segment was removed, the following observations were made.

Macroscopic.—The specimen consisted of a segment of artery measuring 3.75 cm. in length. The artery showed a lumen without any evidence of thrombosis. The specimen showed the ends of the carotid artery attached to a dilated

segment possessing smooth glistening inner walls. The carotid artery at either extremity was of normal size, being about 0.25 cm. These portions of the carotid artery were soft and pliable with a normal character to the inner lining and with no evident change in the wall.

The interposed segment which measured about 2.8 cm. was very different from the tissues of the dog's carotid. In the first place, the lumen was wider than either the proximal or distal ends of the carotid; secondly, the walls of this inserted segment (rabbit aorta) were abnormally hard, irregular in thickness and in a number of places showed a calcareous deposit. The points of junction between the segment and the carotid formed an annular slightly thickened border which projected to a slight degree into the lumen. On holding the opened specimen to the light, it could be seen that the wall was of irregular thickness, and that, opposite the thinner portions, slight secondary sacculations had developed in the tissues of the interposed and dilated segment. The walls of the segment were dense with fibrous tissue and were thicker than the dog's carotid. Broadly speaking the interposed segment formed a fusiform dilatation in which no part of the living carotid to which it was attached was involved. By naked eye it could be seen that the interposed heterologous segment had been clothed both on its inner and outer surface by a living tissue derived from the neighborhood.

FIG. 3a.—Hetero-transplantation. Rabbit aorta on dog common carotid artery. As at time of transplantation.

Microscopical.—Sections were made through the segment of the implanted artery. These sections showed an inner layer lined by endothelium, underneath which a laminated fibrous tissue structure lay between the implanted segment and the lumen. This layer of fibrous tissue was a living tissue showing no structure as is usually seen in the intima of arteries, but was of uniform laminated character from the endothelial surface down to its contact with the remains of the implanted segment. This fibrous tissue layer showed well developed collagen fibres and many fibrous tissue cells lying in small spaces between the fibres. No muscle elements were present.

The mid-portion of the wall was occupied by what remained of the implanted segment. In appearance, the structure was more compact and hyaline than a normal artery. The elastic elements could no longer be recognized with their specific characters. The general direction of the specific fibres could be observed but they were closely compacted and seemingly fused into a homogeneous mass. Scattered through it were a number of connective tissue cells which lay in little lacunæ between lamellæ. On the inner side of the old segment the homogeneous and collagen-like material seemed to coalesce, at least in part, with the collagen fibres of the new inner coat. No inflammatory cells were recognized in or about the old segment and no true granulation tissue was present. The inner border of the old segment was of irregular outline appearing as if absorption of it was in places progressing more rapidly than in others. It is readily evident that the amount of tissue of the original segment had been greatly reduced both through the compacting of its fibres as well as through absorption of its inert matrix at the borders. In the middle of the old segment was a layer of calcareous deposit, which was laid down in collagen fibres in fairly dense arrangement. Nevertheless many small lacunæ were present in this calcareous mass within which cells with round- or spindle-shaped nuclei were found. In

one place a true osteoid tissue was developing in the midst of the calcareous deposit; osteoblasts were present and in the centre of the deposit was a space like a narrow cavity lined by an endosteum and containing groups of irregular cells.

It was very evident that the old segment had become invaded by fibrous tissue cells arising from the host and that a calcareous degeneration and progressive absorption of the original tissue was taking place. It was interesting to observe that the collagen fibres of the inner coat were merging with the matrix of the original segment, as if in the reabsorption of the inert collagen material of the implanted segment these materials were being utilized in the development of the collagen arising in the fibrous tissue of the host.

FIG. 3b.—Hetero-transplantation. Rabbit aorta on dog common carotid artery. Seven months later.

To the outer side of the segment was another laminated layer of connective tissue resembling that beneath the endothelium. Collagen fibres were regularly disposed and contained normal-looking fibrous connective tissue cells. Blood-vessels were found penetrating this coat as far as the old segment; a few lymphocytes were seen about the blood-vessels. This layer was not uniformly attached to the old segment but in places there was a narrow space as if union had never occurred. This layer was quite compact and dense and to the outer side of it was found the loose supporting tissue like an adventitia.

It is clearly evident that the host had supplied the new tissue which clothed the artery on the inner side of the implanted segment as well as the compact structure which bounded the segment on its outer side. There was no longer evidence of an inflammatory response and the tissues had arrived at a passive state when the enclosed segment alone was undergoing change by calcareous degeneration and slow absorption. It is interesting that the segment itself received some of the new connective tissue cells which not only surrounded it but became scattered through its interstices, while some of them in contact with the calcareous deposit took on by metaplasia the property of bone cells with the development of an osteoid tissue.

RESTITUTION OF ARTERIAL CONTINUITY BY MEANS OF DEVITALIZED TISSUE (VEIN) (FIG. 4)

January 22, 1908, dog No. 3.—Medium sized young bitch in good condition. Doctor Guthrie divided the right common carotid artery and interposed and sutured a segment of formaldehyde-fixed vena cava of a dog between the ends

of the artery, thus restoring arterial circulation. The immediate mechanical result was good.[11] The wound was closed and the dog made a rapid and uneventful recovery.

The implanted venous segment had been preserved for sixty days in a 2.5 per cent. solution of formalin. The day prior to the operation the vein was removed from the formaldehyde, washed in dilute ammonia, dehydrated with

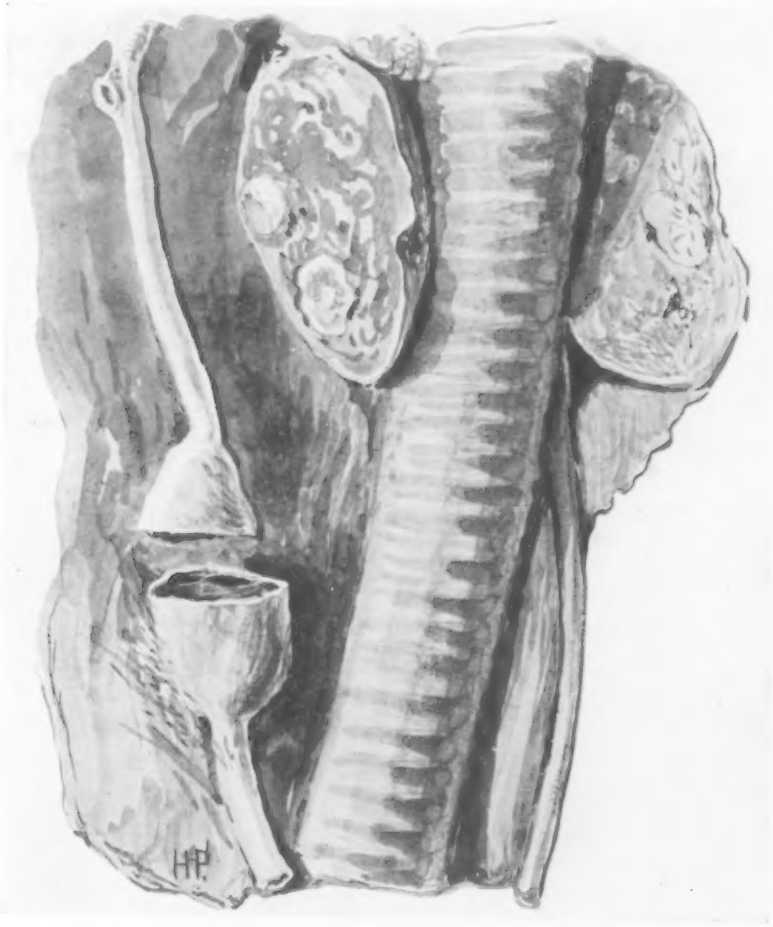

FIG. 4.—Transplantation of devitalized (formaldehyde-fixed) segment of dog vena cava on dog common carotid artery. Eleven years.

absolute alcohol and impregnated with paraffin oil. It measured 0.75 cm. in length and 0.5 in diameter. On establishing circulation, it exhibited a diameter greater than that of the artery.

February 12, 1908. By palpation the pulse in the two common carotid arteries appeared the same. The animal was again anæsthetized and the artery and segment exposed. The circulation through the segment was active. In size the segment showed marked expansion. After temporary occlusion of the artery by pressure on either side of the segment to prove the patency of its lumen and the continuity of the arterial lumen on either side, the wound was closed and again the animal made a rapid and uneventful recovery.

February 29, 1908. Pulsation equal in both common carotid arteries as determined by palpation. The animal was demonstrated on this date before the St. Louis, Mo., Medical Society. The animal remained in good condition and gained much in size. Pulse remained good in both common carotid arteries.

October, 1909. Animal shipped to Pittsburgh where it remained in the Medical School kennels until March 20, 1919, the date of its death which resulted from disease not associated with the experimental operation.

Clinical examination, from time to time, demonstrated equal pulsations in the two common carotid arteries. On the right side, at the site of operation, a dense nodular structure could be felt in the course of the artery. The animal raised pups in 1909–1910, and whelped several times in immediately succeeding years, but failed to raise litters. She remained in excellent condition except after occasional fights with other dogs, until age led to a general physical decline. For about six months prior to death, the decline grew increasingly more marked, and for several weeks preceding death she showed great physical weakness, with loss of appetite; emaciation became correspondingly evident. Two days before death she was barely able to rise to her feet, and was unable to stand for more than a minute. An examination revealed the pulse in both common carotid arteries to be the same by palpation. The animal died suddenly.

An examination shortly after death revealed the two scars of the previous operations, the first, for the operation proper, January 22, 1908, and the second, for exposing the structures for direct examination, February 12, 1908.

A complete autopsy was performed and it was found that the dog had died of a sarcoma of the sternum which had produced metastases in the ribs, heart, liver, spleen, and lymph-nodes. Here we will record only the findings in the cardio-vascular system.

Macroscopic, Heart and Blood-vessels.—The heart, aorta and vessels of the neck were removed in one piece. The heart was enlarged. The left ventricle was well contracted and its walls were hypertrophied. The right ventricle was much dilated; its walls were thin and quite pale. The musculature of right ventricle was quite soft and scattered through it were a number of small yellow areas of tumor formation varying in size from a small wheat grain to a large flat mass which almost completely occupied the right auricular appendix. No tumor masses were observed in the tissues of the left heart. The right ventricle was much dilated and contained dark post-mortem clot. The pericardial sac was clear and glistening. The aorta and its branches at the neck appeared normal.

The right common carotid was patent and could be readily examined up to the point where it entered a fusiform aneurismal sacculation which was 3.5 cm. in length and 2 cm. in width. This mass, which lay along the direction of the common carotid, was shaped somewhat like a large almond and felt quite firm. Along its upper inner border the patent common carotid artery continued. The patency of the vessel was demonstrated up to and beyond its bifurcation. The external carotid shortly after its origin showed the presence of a recent adherent clot and was still pervious. The dilated segment was pervious and communicated with both portions of the common carotid which entered it. This was demonstrated by gently compressing it when it was found that the fluid contents were driven in opposite directions. The mass had an outer sheath of greyish connective tissue which passed in a longitudinal direction while an inner pigmented structure could be recognized through this outer layer. The superior thyroid artery was patent. Careful examination of the surrounding vessels—external jugular and internal jugular—demonstrated them to be patent and normal. The vessels on the left side of the neck were normal.

Implanted Segment of Vein.—A section was made through the middle of the implanted segment which was found to be in a state of dilatation resembling

a fusiform aneurism. When the vessel was cut across a large part of the dilated lumen was occupied by a recent dark red clot, leaving a channel along one edge about the size of a straw. The size of this channel was about the same as that of the carotid artery. The tissues were prepared and sectioned in paraffin. It was found that a process of calcification occupied about one-half of the circumference of the implanted segment and it was necessary to decalcify the tissue before cutting it.

Microscopical.—The sections of the tissue showed a rather peculiar structure. A narrow rim of the original implanted segment of vessel could be followed in almost the entire circumference. This rim of tissue had a hyaline appearance and with Van Gieson's gave a reaction resembling connective tissue. There were no muscle elements to be found. A few granular dots were demonstrated in what was originally the media of the implanted segment; they represented the remnants of the elastic fibres arranged in a circular fashion. Elastic bands no longer existed but only small chains of granules which apparently were undergoing further destruction and removal. On both sides of this tissue, which could be recognized as the remnants of the media of the implanted segment, there was found a connective tissue growth which towards the lumen formed nodular masses arranged in laminæ and bounded on the inner border by an endothelium. This latter coating however was absent in a large portion of the circumference where the blood clot was attached to the vessel wall. The nodular thickening of the inner coat varied much but appeared to be made up entirely of a type of connective tissue. Arising from this inner structure there projected into the lumen a band of tissue which was a part of a fold like a diaphragm which was disposed in a longitudinal direction of the lumen of the vessel. This fold did not completely cross the vessel lumen. It was made up of connective tissue and blood clot was attached to it. On its free surface a reaction resembling a granulation tissue was found and at one point there was a group of cells similar to the tumor cells which were found at the sternum. To the outer side of the media was a tissue mainly of the nature of connective tissue which was quite vascular and to which the artery was attached. This appeared to be the tissue of the surrounding parts for it had various elements such as nerves and large blood-vessels arranged in its structure. The character of the tissues suggested the remains of an old reaction in which granulation tissue had given rise to a fairly large quantity of connective tissue stroma.

Thus the vessel wall as it now exists is seen to be composed of an outer vascularized connective tissue coat of some thickness, which is adherent to a structure of dead connective tissue and partially destroyed elastic fibres (remnant of implanted vessel). Some of the connective tissue from the outside was found to have projected along with blood-vessels into the implanted structure. On the inner side of this old vessel wall is a new connective tissue structure varying in thickness like a nodular endarteritis and from which a band-like fold projects into the lumen.

Products of degeneration were found to occupy the wall of the old implanted vessel. A portion of it showed calcification. In the regions where granulation tissue led to the removal of some of the original transplant, blood pigment was found in fair quantities phagocyted within endothelial cells. Occasional areas of calcification were also found to occupy the thickened masses forming the new intima.

The thrombus within the lumen consisted of a recent blood clot along with cellular structures containing elements like the cells of the tumor of the sternum. It would appear that the tumor mass had localized within the vessel and after growing for some time suffered secondary necrosis, which was readily recognized both in the gross and microscopical sections.

Even with the presence of blood and tumor thrombus a lumen sufficient to preserve the circulation of the carotid remained perfectly patent. Even at this time, the cross-sectional area of the lumen through the segment was greater than the cross-sectional area of the lumen of the artery on either side of the segment.

Carotid Artery.—Sections of the carotid artery taken on the proximal side of the segment showed a healthy unaltered arterial structure.

In this case we have an experiment upon a dog in which a venous segment (devitalized) had served to preserve the circulation of the common carotid artery for a period of eleven years or until the time of her death which resulted from a tumor of bone. The implanted segment which at the time of the original experiment had been devitalized by preservation in formalin persisted in parts of its structure, there still being remnants of collagen and elastic fibres of the original implant. There was a considerable development of connective tissue around the segment which sustained its walls and sufficiently invaded the dead tissues of the segment to firmly hold it in place. This growth of fibrous tissue was the outcome of the development of a granulation tissue. It is interesting that the original dead elements of the segment were not entirely removed. A process of calcification occupied lateral portions of the segment where contact with the granulation tissue was obtained. The inner surface of the segment was clothed by a layer of connective tissue of varying thickness with an endothelial covering. This new inner coat did not appear to have its origin from the periphery, and it is assumed that it has arisen by a process of extension from the inner coat of the carotids to which the segment was united. In some places the new inner coat formed projecting strands not unlike heavy leaflets whose mode of origin was not clear. It is possible that their beginning was associated with small localized thrombi.

The introduced segment and its secondary walls were uniformly dilated to give rise to a fusiform dilatation. The segment was also lengthened. The incomplete thrombus which was found at autopsy was a late process and in part resulted from the localization of metastatic tumor growth, though it is probable that the mechanical conditions prevailing in the lumen, and the slowing of the circulation during the latter days of the animal's life were important contributory factors in the production of thrombosis.

These two cases illustrate very well the late events taking place in implanted vascular segments. The second case which we report is interesting in indicating that an implanted segment can continue to serve adequately as a conduit for the blood for a period of at least eleven years.

It has been shown that in hetero-transplants very probably and in devitalized transplants certainly the permanent effectiveness of the operation is due entirely to proliferative activity on the part of the living tissues of the host, both the vascular endothelium and the connective tissues taking part in the process of vitalizing the engrafted segment. The active proliferation of the living tissues may be augmented by certain mechanical factors associated with the flow of blood through the transplant, under which are to be considered: (1) The distention and movement of the segment due to blood

pressure. (2) The mechanical infiltration of the segment by blood plasma before it becomes lined by endothelium. There are also certain factors associated with the processes of reaction and repair following the introduction of the graft; (1) the resurfacing of the lumen by endothelium, with the subsequent development of a layer of subendothelial connective tissue, and (2) the deposition of fibrin about the graft as well as the simple presence of the graft itself as a foreign body in the tissues, both of which stimulate connective tissue growth.

The latter factor readily lends itself to investigation and an experiment to determine its importance was performed on a young dog, in which the object was to bring a vascular segment into close proximity to a large vessel without forming any connection whatever with the circulation. Segments of formaldehyde-fixed dog's veins were prepared from the material employed in earlier experiments with fixed transplants. The segments were treated in the same way as for artery grafting. A dog was subjected, under ether anæsthesia, to the usual operative procedure necessary to expose the right common carotid artery. Three prepared segments were anchored at equal distances along the course of that vessel, and secured by a loose loop of fine silk thread around the artery, after which the wound was closed. Healing occurred promptly without evidence of infection. The dog was kept under observation for eight months (June 22, 1920, to February 15, 1921), and at the expiration of that time the animal was employed in a class demonstration. The implanted segments were recovered at autopsy. In the gross, the implants were identified as three small indurated nodules along the course of the right common carotid artery; they were about the size of a split pea, irregular in shape, and in color varying from a yellowish-white to a brownish-grey. They showed no definite increase in size, nor was there any gross evidence of active tissue proliferation about them. They were preserved for microscopic study.

After fixation, the tissues were cut in paraffin and duplicate sets of sections from each nodule were stained by hæmatoxylin and eosin, Mallory's anilin blue stain, Van Gieson's stain, phosphotungstic acid hæmatoxylin, and by Weigert's and Verhoeff's elastic tissue stains. Control sections were also made from the same fixed dog's veins that had supplied material for the implants.

The microscopic findings may be summarized without going into the details of each implanted segment, since the three were practically identical. The control segments (from the vena cava of a dog) showed the typical histologic structure of a large vein, in which the two striking things are the very narrow medial coat and the wide fibrous adventitia; in the latter, great quantities of collagen and many short wavy elastic tissue fibres are present. These were, of course, cut transversely to the long axis of the vessel, an advantage not possible in the study of the implanted segments of vein, as much distortion had occurred during the eight months following the operation. One of the three segments appeared in the section properly cut in the transverse diameter. The others were cut obliquely. In general, the implants were found to have preserved enough of their structure to enable one to identify them and even to distinguish the media and the adventitia. Nuclear staining, however, was lacking and the muscle tissue of the media showed no differential staining when special methods were used. The entire implanted segment took a diffuse stain such as occurs in degenerated tissue. The elastic fibres were an exception. They were recognizable by their pale buff stain and refractile quality with phosphotungstic acid hæmatoxylin and by their black or blue-black stain with the special elastic tissue methods. Thus it is seen that there was every evidence of degenerative change in the elements of the

transplanted segments with only the elastic fibres retaining any degree of their specific staining quality. The cells and collagen fibres were also swollen somewhat and the structure of the vein wall was loosened, especially at the periphery. This was largely the result of a slight connective tissue proliferation, which had occurred in the immediate vicinity of the implanted tissue following a very mild inflammatory reaction due, no doubt, to its presence. No evidence of inflammatory cell exudate was present and there was no indication that granulation tissue had formed in the reaction. Adipose tissue had filled interstices about the borders of the implanted vascular segment and appeared in small areas in the periphery of the degenerating adventitia.

In the histologic elements of segments of a devitalized vein implanted in the tissues alongside the intact common carotid artery there developed, after eight months, such extensive disintegrative changes that only a certain number of the elastic fibres retained differential staining quality adequate for identification. The original question of the ability of such tissue implants to induce extensive encapsulating fibrosis by their mere presence must be answered in the negative, since it was shown by this experiment that the response of the living tissues is of the slightest degree, consisting of nothing more than the slow development of a few connective tissue cells, which grew for a short distance into the implant and which, together with adipose tissue, simply tended to obliterate any sharp line of demarcation between living and dead tissue.

The perivascular implantation of devitalized vascular segments indicates that the mere presence in the tissues of implants of this type, with the associated fibrinous exudate incident to the operative procedure, is capable of stimulating only a slight proliferation of connective tissues. It would therefore seem probable that the mechanical factors mentioned, either directly or by leading to a greater infiltration of blood plasma into the engrafted tissues, or possibly its escape into the surrounding tissues, account for the differences in the tissues implanted by the two methods.

The final result of the implantation of vascular segments from the functional standpoint is very similar, whether the segments are living or dead, whether they are homologous or heterologous. This has also been the experience of others. Furthermore it is found that hetero- or devitalized implanted segments always suffer more or less aneurismal dilatation, wherein there is some danger of the development of secondary thrombosis. These dilatations are usually fusiform, increasing the size of the lumen beyond the original diameter.

Surviving heterologous or devitalized vascular segments undergo extensive disintegrative and absorptive processes. It is therefore evident that in inserting such a vascular segment between the divided ends of an artery or vein, we are only attaching a temporary organic frame-work which is capable of serving as a tube to carry blood, and which is later more or less replaced by a permanent living structure, by the tissues of the host. The cellular portions of these transplants are lost and undergo autolysis, but the interstitial substance, particularly the elastic fibres and the collagen fibres of the

connective tissue, resist the process of dissolution for considerable periods of time. The tissue substances become more resistant when treated with formaldehyde solution. The colloidal state of the fibres is altered. Thus a formaldehyde-fixed segment will retain its shape and structure longer than will the untreated segment. This insolubility of the tissue has an advantage in that one can feel secure that the segment will not give way under the blood-pressure during the reëstablishment of the new vessel. However, it also has the disadvantage that it does not adapt itself to the growing tissue.

Nageotte [12] and others believe that they have been able to demonstrate a repopulation by cells, of the inert interstitial structures of fixed connective tissue, when these were implanted in vascular areas. The collagen fibres of implanted segments lend their substance to reconstruct new fibres, and it is even stated that the old inert fibres become welded to the new ones, so that no division btween old and new can be recognized. That such welding or amalgamation does occur between the inert substance of old and new fibres, we have been able to observe in a number of instances, but we are not convinced that this is a permanent fusion. It appeared to us that fusion of fibres was a physical fusion of two colloidal substances, whose properties were not necessarily identical, as is evidenced in the greater attraction of calcium salts by the altered fibres of the implanted segment. Even after such fusion of fibres, those of the implanted segment continue to undergo change, being slowly absorbed and replaced by new substance. Only when the fibre has been encrusted with calcium salts does the process of absorption and replacement come to an end.

It is probable, as Villard, Travernier and Perrin [13] state, that blood-vessels preserved in the refrigerator before implantation are not living structures as was claimed by Carrel and are destroyed and absorbed like other killed segments. They only represent an elastic skeleton of the artery, susceptible always of being invaded by the cellular elements of the host which furnish a vitality sufficient to assure continuity of the vessel on which it is implanted.[14] Thus the strength of the segment is at first dependent upon the compact inert elements of its wall, but later these give way to the increasing responsibility assumed by living tissue growing into the segment from the tissues of the host. Analysis of Carrel's reported observations bears out this view.[15] For the instances in which he claims to have observed muscle tissue, months after the operation, in segments of dog's arteries kept in an ice box for weeks before engrafting between the ends of divided arteries of dogs, merely agree with the well-known fact that time is required for the complete disintegration and absorption of engrafted devitalized tissue.

His reported findings further confirm the fact, well known to surgeons, that absorbable tissue (catgut) is rendered more resistant to absorption by impregnation with vaseline.[16] For he states that tissues kept in vaseline before use gave better results than tissues kept in salt solutions or blood. In the three successful operations reported with the use of vaseline-treated

arterial segments, examinations after three, five, and six months respectively showed that disappearance of muscular tissue was proportional to the time between operation and examination. Also, the results tend to show that the magnitude of change varies directly within limits with the time the tissue was kept in cold storage, *i.e.*, when transplanted after only twenty-four hours in cold storage, three months later good preservation of structure was observed, while segments transplanted fourteen to twenty-three days after being placed in cold storage showed much more extensive alteration when examined five and six months later.

In the first of these experiments in which the segment had only been excised for twenty-four hours, the tissues may have retained a certain degree of vitality, for, as is well known, blood-vessels or even the heart may be caused to show contractile response some days after their removal.[17] MacWilliam and Mackie [18] observed contraction in arteries from amputated limbs in response to mechanical stimulation after twenty-four to forty-eight hours, but there was slight effect from chemical stimulation after the third day.

Carrel's results are of particular interest in showing that, in comparison to venous segments employed for arterial restitution, arterial segments may show but little dilatation enlargement over periods up to six months. This difference in the behavior of arterial and venous segments is accounted for by the differences in the thickness and structure of the walls, the arterial not only being much the thicker, but especially by the relatively more abundant elastic tissue fibres with their relatively great resistance to disintegrative and absorptive processes. Notwithstanding these qualities, arterial segments are reinforced by encapsulating connective-tissue proliferation as are venous segments. This is well illustrated by one of Carrel's figures in which this fibrous reinforcement of the segment is included in the drawing.[19]

The vitalization of such tubes takes place from two sides. Firstly, the lumen of the tube is rapidly clothed by a layer of endothelial cells, growing from the ends of the intima of the cut vessel, and secondly, the outer surface of the segment becomes surrounded by a granulation tissue of only moderate intensity. It is this external granulation tissue which actively reconstructs the tube, and which utilizes the framework of the inserted segment to permit new living cells to populate the foreign structure. The granulation tissue brings no muscle fibres with it to replace this type of tissue of the media. Connective-tissue cells are the only new cells which assist in reconstruction. These same cells may, under conditions of metaplasia, give rise to bone and cartilage.

The speed with which endothelial cells can clothe a denuded surface is always striking. An artery which has had the endothelial cells removed from its intimal surface will show complete regeneration in forty-eight hours. A quiescent thrombus will become covered by an endothelial layer in an equally short time. It is probable, although we have no studies upon this point, that an endothelial tube is reconstructed within an implanted segment within a

very short time. These endothelial cells develop by continuous multiplication, forming plaques which although usually only one layer deep often show areas which are three, four or five cells deep. No subendothelial fibroblasts develop at this time. The endothelial cells gain their nourishment from the circulating blood within the tube, and proliferate independently of the other tissues.

The disintegrative processes which are always found in devitalized or non-surviving implanted segments occur in the implanted portion itself. These degenerations are most commonly of a calcareous nature and will be observed after a period of four or five weeks. The calcareous process continues to increase for many months until the entire structure appears converted into a more or less brittle tube. As, however, portions of the implanted segment are absorbed, and as the rate of absorption varies with the different kinds of segments, the actual amount and distribution of calcification in any particular specimen varies greatly. In relation to these deposits of lime salts it is not uncommon to find small islands of osteoid tissue lying between the calcareous mass and the granulation tissue which surrounds it.

Thus, however, with all the changes which take place within the implanted segment, and around it, we find that such a segment can serve the purpose for which it is adapted. It serves as a conduit for the circulating blood, and as a framework upon which is built a new tube by the tissues of the host.

In all instances in which a dead segment serves its purpose for more than a month or six weeks, we find that an aneurismal dilatation occupies its length. This fusiform sacculation persists not only during the existence of the segment, but permanently with the reëstablishment of the new tube. The presence of such a fusiform dilatation may predispose to the development of a thrombus at a time long after the effects of the operative interference have disappeared as is the case with true aneurisms. Usually the extent of the sacculation is limited, but it may attain considerable proportions in relation to the vessel to which the segment has been attached. In one of our cases the aneurismal pouch became the site for the localization of a metastatic tumor growth, around which a thrombus subsequently formed. The development of saccular dilatation in these living heterologous or dead segments further substantiates the evidence that the most important lesion which leads to dilatation is a loss of the strength of the media. It is the structure of the media in the implanted segments which is never accurately reproduced. As we have said, the reconstruction of the segments fails to replace the lost musculature as well as a great portion of the elastic fibres. In the absence of these tissues, the strength and elasticity of the restored artery is reduced regardless of how well the injury may be repaired by connective tissue. Dilatation is the natural consequence, and it will continue until the resistance of the new tissues in the adventitia can withstand the blood-pressure within the artery. In the second experiment here recorded, this dilatation persisted for a period of eleven years without interfering with the circulation.

BIBLIOGRAPHY

[3] Carrel and Guthrie: Surgery, Gynecology and Obstetrics, 1906, vol. ii, p. 266. Guthrie Blood-vessel Surgery, Arnold, London, 1912, p. 17.
[5] Carrel: J. Exp. Med., 1907, vol. ix, p. 226. Guthrie, Am. Jour. Phys., 1907, vol. xix, p. 482.
[7] Guthrie: Science, 1908, vol. xxvii, p. 473. Guthrie, Science, 1909, vol. xxix, p. 29. Guthrie, J. A. M. A., 1919, vol. lxxiii, p. 186. Guthrie, J. A. M. A., 1908, vol. l, p. 1035. Guthrie, Blood-vessel Surgery, pp. 10, 89.
[4] Carrel: J. Exp. Med., 1912, vol. xv, p. 389.
[5] Watts: Bull. Johns Hopkins Hosp., 1907, vol. xviii, p. 153.
[6] Fischer and Schmieden: Frankfurter Zeit. f. Path., 1909, vol. iii, p. 8.
[7] Levin and Larkin: J. Med. Research, 1909, vol. xxi, p. 319.
[8] Guthrie: Blood-vessel Surgery, p. 85.
[9] Guthrie: Blood-vessel Surgery, p. 87.
[10] Guthrie: Am. Jour. Phys., 1907, vol. xix, p. 482. Guthrie, Blood-vessel Surg., p. 90.
[11] Guthrie: Interstate Med. Jour., 1908, vol. xv. Guthrie, Science, 1908, vol. xxvii, p. 473. Guthrie, Blood-vessel Surgery, pp. 91, 93. Guthrie, J. A. M. A., 1919, vol. lxxiii, p. 189.
[13] Nageotte and Sencert: Comp. Rend. d. Seances et. Men. d. l. Soc. d. Biol., 1919, vol. lxxxii, p. 45.
[13] Villard, Tavernier et Perrin: Lyon Chirurgical, août, 1911.
[14] Guthrie: J. A. M. A., 1908, vol. l, p. 1035.
[15] Carrel: J. Exp. Med., 1910, vol. xii, p. 460.
[16] Bartlett, Willard: J. A. M. A., 1906, vol. xlvi, p. 1168.
[17] MacWilliam: Proc. Royal Soc., 1902, vol. lxx.
[18] MacWilliam and Mackie: Proc. Phys. Soc., 1906, Jour. Phys., vol. xxxiv, p. 34.
[19] Carrel: *Loc. cit.*, Fig. 4.

RELATION OF SURGERY TO THE VASCULAR SYMPATHETIC SYSTEM*

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The following anatomic and physiologic facts have been well established and are generally understood and accepted. The walls of the arteries are supplied with both medullated and non-medullated nerve fibres. The former are a part of the central nervous system, while the non-medullated fibres are axones of the sympathetic system and form a part of what Langley terms the autonomic system. Although related to the brain and spinal cord by means of so-called pre-ganglionic fibres, they all reach their final distribution in the periphery by way of the sympathetic ganglia and after their emergence from these are known as post-ganglionic fibres. The ganglia and their associated fibres form a network which surrounds the blood-vessel as a part of its sheath and adventitious coat. Finally, these fibres penetrate the wall of the vessel and terminate in involuntary or non-striated muscle cells.

By means of their control of the muscular structure of the vessel wall, the sympathetic fibres act, under the effect of reflex stimuli, as dilators or constrictors of the arteries, arterioles and capillaries, and are, therefore, known as vasomotor nerves. Whether this action is an independent one or associated with central control, is a matter of controversy, but the anatomic arrangement of the pre-ganglionic fibres would suggest at least a correlated function with the brain and spinal cord.

Under normal physiologic conditions, a proper balance is maintained in the control of pulse-rate, blood-pressure and the volume of blood supplied to a given part. We are all familiar with the circulatory phenomena of shock, anger, and fear, and local anæmia and hyperæmia are under the control of this complicated vasomotor mechanism in which the sympathetic system plays a most important part.

Without opening up the entire field of speculation on the possibilities of surgery as related to disorders of the sympathetic system, it may not be out of place to recall that surgeons have attempted to correct disturbances of the form and function of various regions of the body, notably in the head and neck, by removal of sympathetic nerve ganglia. Based partially on the knowledge of the effects of irritation of the cervical ganglia of the sympathetic on pulse-rate and intraocular tension, Jonnesco, Jaboulay and others as early as 1889 removed one, two or all three of the cervical ganglia on one or both sides of the neck in cases of glaucoma and exophthalmic goiter. In Jacksonian epilepsy and tic douloureux, Jonnesco also employed the same method for the purpose of converting cerebral anæmia into hyperæmia, but as

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the effect of such modification of circulation is but a transitory one, the hypothesis does not hold good as a means of permanently relieving such conditions, and while a few cases were reported in which improvement or relief was apparent, as indicated by lessened intraocular tension, lowered pulse-rate, diminution in the size of the lobes of the thyroid and remission of pain in the cases of tic douloureux, the procedure has for the most part fallen into disuse and was abandoned as unsound and impractical.

The writer recalls one case during his internship in which G. R. Fowler excised the cervical ganglia of the sympathetic in the treatment of an advanced case of Graves' disease. The result was a disappointment, and no other similar case has since come under personal observation in which this method seemed justifiable.

In 1889, Jaboulay conceived the operation of periarterial sympathectomy and performed it with good results on the femoral artery in cases of perforating ulcer of the foot and to a less satisfactory degree on branches of the cœliac axis in certain visceral disorders in which the abdominal sympathetic system seemed to be at fault.

During the past twenty years little or nothing has been contributed to the literature in this field of surgery until Leriche, of France, a former pupil of Jaboulay, published a series of papers setting forth the results of his experimental work on the study of periarterial sympathetic phenomena. In 1921, Leriche presented the results of his research before the American Surgical Association. These observations were published in the ANNALS OF SURGERY in October, 1921, together with a most interesting account of his personal clinical experience in the application of this almost obsolete principle to the surgical treatment of certain pathologic and physiologic vasomotor disturbances of the extremities.

Leriche's experimental work verified and accentuated certain facts which in part were previously understood in relation to neurovascular phenomena and were briefly as follows: I. When the sheath of an artery is removed, the vessel begins to contract as soon as its external layer is pinched or traumatized; its pulsation lessens and its calibre diminishes. If the loose areolar tissue and adventitia are excised, the diminution in size will progressively increase, while the segments on either side of this area maintain their normal size if not injured. This contraction is the primary result of the normal reaction to excitation. It persists for several hours and is characterized by feeble pulsation of the vessel, coldness of the extremity, a blanched appearance of the skin and loss of function. These are the same phenomena which are present in the so-called syndrome of "steupeur arterielle" following trauma without gross injury to the vessel, but which, because of its close resemblance to gangrene, resulted in a number of unnecessary amputations during the war.

II. The secondary phenomena which occur several hours after excision of the sympathetics from the vessel wall are an elevation of local temperature of two or three degrees centigrade, a subjective sensation of heat, a local

rise in blood-pressure and evidences of a peripheral hyperæmia. The secondary reaction is transitory, becoming attenuated after five or six days, and disappearing after three or four weeks. These reactions are characteristic and according to Leriche, never fail if the resection of the tissues containing the nerve structure has been complete.

In applying the results of this experimental work to practice Leriche found it somewhat difficult to classify the vasomotor neuroses in which sympathectomy, so-called, might be applied, but he states that there are two large groups or types in which its application should be considered.

TYPE I. Active secondary spasm, or the so-called spastic anæmias, due to sudden or prolonged excitation of traumatic or toxic origin, as illustrated in the first instance by the above-mentioned "stupeur arterielle," and in the second, by Raynaud's disease, in which the symptoms are typical of vasomotor sympathetic disease. This group also includes the painful ischæmias and deformities which sometimes involve an entire limb, in which all of the vascular sympathetics are involved, as in cases of irritation or pressure from a cervical rib.

TYPE II. In this group there is a disturbance of physiological and biological function, in which the cause is not well known, but induced by prolonged contraction of the vessels or abnormally persistent dilatation. There are associated disturbances of motor, sensory, glandular and trophic origin, leading possibly to local necrosis, as illustrated by perforating ulcer of the foot. In this group are included the painful stumps and causalgias first described by Weir Mitchell, stiffness and contracture of muscles, as in Volkman's ischæmic paralysis, the intermittent claudication in certain forms of chronic arteritis or endarteritis obliterans and all forms of trophic ulcer.

Reasoning from the above analogy, Leriche was led to believe that the logical treatment of these vasomotor and trophic disturbances must aim to modify peripheral circulation by removal of the periarterial sympathetics.

The operation of sympathectomy was performed by him sixty-four times in causalgias, painful stumps, contractures following trauma, trophic ulcers, intermittent claudication, trophœdema, frost bite, Raynaud's disease and several other conditions of neurovascular origin.

In the painful phenomena the results were extremely satisfactory except in painful stumps. It gave excellent results in two cases of Raynaud's disease, and in the trophic ulcers it was very efficacious. It did not prove satisfactory in frost bite or perforating ulcers, and was inferior to resection of neuromata followed by nerve grafting in the cases of painful stumps and trophic disturbances following section of a large nerve trunk.

The good results obtained are presumably due entirely to improved local circulatory activity, and the writer has long felt that if some method could be devised for producing a sustained improvement in local circulatory conditions it might be possible to solve many of our difficult surgical problems of the extremities in which disturbed or defective arterial circulation is a factor. This principle was recognized by Bier some years ago in advocating methods

for the production of passive hyperæmia by mechanical means, a measure which proved helpful as an adjunct in the treatment of a variety of chronic lesions of bones, joints and soft parts.

While interested in Leriche's work, I recalled a patient who had been under our observation in the Surgical Clinic of the Brooklyn Hospital for several years with an ulcer of an amputation stump which had persisted in spite of a prolonged period of surgical treatment and observation.

CASE REPORT

F. Y., male, aged thirty, had an amputation of the right leg twenty years ago. The amputation followed a severe traumatism and was done about four inches below the knee-joint. The stump never healed satisfactorily, and although the patient wore an artificial leg and was able to get around, he was constantly returning to hospitals and dispensaries because of the unhealed stump. The artificial peg-leg was correctly fitted and in no way produced pressure; when left off for prolonged periods, the ulcer showed no tendency to heal. Eight years ago the stump was revised at operation, but the wound again broke down. In November, 1921, he complained that the stump was cold and gave him constant pain. He was sent to the hospital for observation, and at that time we did a plastic resection of the scar, excised the bulbous nerve end and resutured the muscle and fascial planes. Great care was used in the approximation of healthy skin flaps. This was followed promptly by a failure to heal and the reformation of two good-sized ulcers which were continuously painful and had a deep, indolent, sloughing base. The sensation of coldness persisted and the surrounding skin remained blue. Two months later he again entered the hospital because of constant pain and annoyance from the unhealed ulcers. With Leriche's work in mind, the operation of periarterial sympathectomy was proposed and accepted by the patient after all other measures had failed to produce relief.

The popliteal artery of the affected leg was exposed along the outer border of the semimembranosus tendon and isolated for a distance of eight or nine centimetres by means of two traction sutures passed around the vessel above and below. In this way it was held free of the surrounding structures. With mouse-tooth forceps and a straight-bladed knife, the sheath of the artery was first dissected away from the freed portion of the vessel and then by further dissection and a shaving process the loose areolar tissue and adventitia were removed, leaving the muscular wall of the vessel bared. The phenomena of immediate contraction was present. The operation was completed in the manner described by Leriche and the wound was closed. The stump and ulcers were left undisturbed. On the day following there was complete relief from pain, which up to the time of operation had been constant and most annoying. There was an increase in local heat and peripheral hyperæmia. Both ulcers, which had previously resisted all efforts to promote healing, within a week became superficial and assumed a healthy red appearance, following which epithelialization was rapid and continuous.

It is now one year since this patient left the hospital, during which period he has been seen and examined at regular intervals. He has remained entirely free from pain, and there has been no evidence of ulcer reformation. The skin covering the stump still remains somewhat bluish in color and cold in comparison with the surface temperature of other parts of the body.

Since operating on this patient, five other patients in the surgical wards of the Brooklyn Hospital have been subjected to periarterial decortication. Two of these occurred in the service of the writer and three in the

service of Dr. J. E. Jennings. All five of these were cases of endarteritis obliterans with impending or actual gangrene of varying degrees. The operation was attempted in each instance merely as a palliative measure for the relief of intolerable pain. In three cases the relief was immediate and added much to the comfort and happiness of the patients for considerable periods of time or until amputation was indicated or necessary. In one case the operation was a failure because of the brittle character and consequent accidental wounding of the vessel. This made necessary an immediate amputation, which, although contemplated, we hoped to postpone until observations had been made on the degree of palliative relief obtained. In the fifth case relief from pain was not so marked, but temporary only. In this instance the result could not be looked upon as satisfactory.

Recent contributions to the literature by Callander, Lehman, A. E. Halsted and others, while expressing a wide difference of opinion on the correctness of the principles involved and the value of the operative procedure as a means of relief in the conditions mentioned, would, nevertheless, indicate an increasing interest and clinical experience in the application of surgery for the relief of vasomotor disturbances in which the sympathetic ganglia seem to play an important part.

To those of us who had followed the course of the patient above reported in detail, the outcome was both unexpected and gratifying. Our limited experience taken in conjunction with the much larger clinical opportunities of Leriche, would seem to open up a rather wide field for experimental work and further study in a large group of cases which in the past have been both troublesome and discouraging in the application of medical and surgical resourcefulness.

In many of the painful and intractable lesions of the extremities, including some of the neuritides, in Raynaud's disease and in trophic ulcers, as well as other chronic lesions in which inadequate peripheral circulation seems to be a factor, I should not hesitate to consider removal of the arterial sympathetic ganglia as a possible means of palliation or relief.

The operation may be done simply and with little or no detriment to the patient. It seems, therefore, to offer possibilities which are well worth our time and consideration.

ANTHRAX AND ITS TREATMENT

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Since 1915, when Eichhorn in this country first made available through the Bureau of Animal Industry in Washington a specific serum therapy for human anthrax, the treatment of this condition has gradually been revolutionized. Evolution in therapy, however, has been slow as a result of the fact that few institutions in this country are called upon to treat this disease with much frequency. At Bellevue Hospital where the Isolation Service receives these patients from the Borough of Manhattan, there have appeared since the beginning of 1915, forty cases in which the clinical diagnosis of anthrax has been made from the characteristic appearance of the primary focus and in which laboratory confirmation of such diagnosis has been obtainable in almost all. During this time, treatment has gradually changed from supportive and surgical through the stages of surgery combined with serum until now it is the general feeling of those who come in contact with this disease in the form of malignant pustule that surgery as such has no place in the treatment of this lesion; that its use may be directly harmful in the dissemination of the infection, in that complete removal of the infection is practically impossible by such means; that serum therapy presents the best prospect of a cure.

A brief resumé of the cases since 1915 is presented through the courtesy of Doctors Hooker, Hartwell, Stewart and Smith, the directors of the four surgical divisions who assume responsibility for the outside service in rotating periods of six weeks each. Only eight of these cases have been observed personally.

In a review of the above cases certain points may well be emphasized on both the clinical and therapeutic sides. Etiologically the number of cases directly traceable to the use of new shaving brushes has already been pointed out.[1] As a rule these brushes have been of the cheapest variety. Control and limitations upon the use of horse hair without previous sterilization in the manufacture of such brushes have now been made sufficiently strong so that the incidence of the disease from this source should be largely eliminated.[2] The site of the lesion in practically all of these cases was face or neck, the lesion itself in a striking number of cases, as determined by history, taking thirty-six to forty-eight hours to develop to the stage where medical advice was sought. At this time its clinical appearance was very characteristic in the vast majority of cases, with blackish dry central eschar slightly depressed below the surrounding zone of superficial redness on which show more or less numerous small vesicles with clear content, this zone changing abruptly to normal or glossy looking skin outside, the entire lesion

and surrounding tissues being the site of an œdema that is huge and extensive in the elapsed time. Striking are the absence of pus, the absence of much pain or tenderness, the non-pitting or semi-solidity of this huge œdema, and in most of these cases the absence of enlargement of the draining nodes. In these cases, probably due to the site of the lesion, associated dysphagia and respiratory embarrassment have been fairly frequent. However, œdema of the pharynx and glottis have been soft and in one case multiple incisions through mucous membrane at this site seemed a life-saving measure.

The period from forty-eight to ninety-six hours seems to be the time in which a septicæmia is most apt to develop. No evident clinical signs or symptoms make the onset of this septicæmia apparent. Hence the importance of a blood culture at the time of admission together with direct smears or cultures from the lesion should be emphasized. That this septicæmia makes the disease a rapidly fatal one is evident from the fact that nine of the above fourteen fatal cases died within twenty-four hours after admission and seven of these within twelve hours. In eight of these fourteen cases the septicæmia was proved by culture. In the remaining six death occurred in the same manner without complicating conditions which could be considered as directly causative.

Temperature reaction in these cases in which death supervened gave no indication of prognostic or diagnostic importance. It varied in proved septicæmic cases from 98° to 106°; the very low temperatures, however, usually occurring in those individuals who were very toxic on admission or in a condition bordering on collapse. In five septicæmic individuals where blood counts were made, a leucocytosis varying from 14,000 to 39,000 was encountered, a polynucleosis varying from 83 per cent. to 92 per cent. The leucocytosis in these cases seemed to increase as the septicæmia increased. Several autopsy reports showed in addition to the septicæmia an œdema of the superficial and deep tissues of the body, a pial œdema or congestion with the formation of small hemorrhagic foci, hemorrhagic foci in the small intestine or mesentery, and hydrothorax, hydro-pericardium or hydro-peritoneum, such fluid being at times blood tinged.

An analysis of the above cases for therapeutic indications shows certain striking facts. Prior to 1920, when intensive treatment with serum was begun, twenty-one cases were admitted with eleven deaths (52.4 per cent.), three of these deaths occurring so quickly that no operative or serum therapy was used. Of the remaining eighteen cases with eight deaths (44.4 per cent.), fourteen were treated by excision plus antiseptics plus serum with four deaths (28.5 per cent.), two of these being septicæmias on admission; four were treated by serum alone, four died, three receiving a single dose intravenously of approximately 40 c.c. before death; the fourth receiving 40 c.c. daily for five days and dying on the fifth day. This last case was from the standpoint of serum therapy unfortunate in that it was the first case on which serum alone was used (in 1915) and the result was discourag-

TABLE I.

THIRTY-SEVEN CASES TREATED BY SERUM.

Case No.	Age	Occupation	Etiology	Day of disease	Site of lesion	Direct		Blood Culture	General condition	Operative	Antiseptic	Intravenous c.c. in days.					Local c.c. in days.					Result	Remarks.
						Smears	Culture					1	2	3	4	5	1	2	3	4	5		
1	52	Hides	Abrasion	?	Chest	+	+	+ (autopsy)	Poor													Died	Death in thirty-six hours.
2	72	Lawyer	?	2	Neck	+	+		Fair			40	45	40	40	40						Died	Death on fifth day.
3	17	Candy packer	?	?	Chest	+	+	+	Poor			40										Died	Death in eleven hours.
4	39	Hides	Abrasion	2	Hand	+			Good	Excised	Phenol	45	30			12			40	50		Cured	
5	37	Gardener	?	4	Cheek Neck				Poor			10	25	50								Died	Death in forty-eight hours.
6	54	Longshoreman	Hides	2	Neck	+	+		Good	Excised	Serum	50	100									Cured	
7	36	Longshoreman	?	4	Neck				Poor	Excised												Died	Death in twenty-four hours.
8	28	Peddler	?	?	Cheek	+	+	+	Bad													Died	Death in five hours.
9	30	Longshoreman	?	3	Neck	+			Bad			100										Died	Death in nineteen hours.
10	57	Longshoreman	?	4	Neck	+			Good	Excised	Bichloride	25	45	45	45	45						Cured	
11	26	Longshoreman	?	2	Neck				Good	Excised	Dichloramine-T	50	50	50	50	50						Cured	
12	41	Laborer	?	4	Neck	+	+	+	Bad	Excised	Phenol	45	45									Died	Death in thirty-two hours.
13	30	Hides	Shaving	3	Cheek	+		+	Fair	Excised	Phenol	90	90	225								Died	Death on fourth day.
14	35	Laborer	?	3	Cheek	+		0	Good	Excised	Phenol	45										Cured	
15	19	Necktie maker	?	4	Cheek	+	+	0	Good	Excised	Phenol	10	10	10		10						Cured	
16		Concrete mixer	Shaving brush	3	Neck	+			Good	Excised		10	10	10	10	10						Cured	Received ten c.c. for nine days.
17	32	Waiter	Shaving brush	2	Cheek	+			Good	Excised	Chinosol	20	20	20	20	20						Cured	Received twenty c.c. for six days.
18	46	Fireman	Shaving brush	2 (?)	Cheek Hand	+			Bad													Died	Death shortly after admission.

19	47	Farmer	Shaving brush	2	Cheek	+	+		Good	Excised		90	90									Cured	Received thirty c.c. q. 4 h. for six doses.
20	21	Packer of brushes	Shaving brush	4	Neck	+			Fair	Excised		40	40									Cured	Received thirty-five c.c. on sixth and tenth days.
21	59	Cook	Shaving brush	?	Neck	+			Bad	Excised		40										Died	Death in five hours.
22	32	Driver	Hides	2	Neck	+	+	0	Fair			200	200	200	200		60	60	40			Cured	
23	39	Builder	Shaving	2	Neck	+		0	Good			80	200	200	80	80	20	50	50	20	20	Cured	
24	36	Milliner	Horse hair braids	3	Chin		+	0	Good			80	80	120	120	80	20	40	20	20		Cured	Also received occasional intramuscular serum injection.
25	37	Dealer in ponies	?	2	Cheek		+	0	Good								50	50	50	50	50	Cured	Received only local injections, ten c. c. q. 4 h.
26	45	Shoemaker	?	?	Cheek		+	+	Bad			40					10					Died	Death in five hours.
27	44	Celluloid worker	?	?	Hand	+	+	0	Good			80	160	160	160		20	40	40	40		Cured	
28	16	Celluloid worker	?	4	Cheek	+	+	0	Good			80	200	200			20	50	50			Cured	Lesion sterile on third day.
29	14	School	?	5	Cheek	+	+	0	Good			150	150	150	150		50	50	50	50		Cured	
30	28	Tailor	Shaving brush	4	Cheek	+	+	0	Good								50	50	50	50	50	Cured	Received only local injections, ten c. c. q. 4 h for six days.
31	38	Plumber	Shaving brush	4	Cheek	+		0	Good								10	10	10			Cured	Received only local injections, ten c. c. each day, for three days.
32	39		?	?	Chin	+		0	Good					20			50	50				Cured	
33	56	?		2	Cheek	+	+	+	Bad			150					15					Died	Death in four hours.
34	49	Farmer	Shaving brush	2	Neck	+		+	Fair				750	200			45	40	30	50		Cured	Blood culture sterile in twenty-one hours after first intravenous injection.
35	38	Salesman	Shaving brush	3	Cheek	+		0	Good			30	240				10	40	10	10		Cured	
36	23	Salesman	Shaving brush	2	Cheek	+		0	Good			100	100	190	50			10	10	20		Cured	
37	40	Longshoreman	?	4	Cheek	+		+	Bad			200	200					20	20			Died	Death in seven and one-half hours.

NOTE.—Three cases omitted because of incomplete records.

ing. In the light of later experience, perhaps the time elapsed before death should have been encouraging rather than otherwise.

In 1920, the use of serum intensively was begun, accompanied by no operative interference. Of the sixteen cases admitted since this time, three died (18.7 per cent.), all within 7½ hours of admission (4, 5, 7½ hours). All of the three were septicæmias on admission. Of the thirteen cured, one was septicæmic on admission.[3] In these thirteen cases the records of three show the use of local serum injections only, two receiving 10 c.c. every four hours for five days, one receiving 10 c.c. each day for three days. That this type of local specific therapy may be used to advantage seems borne out by the observation of Marchoux[4] that it facilitates phagocytosis and by the experience of Regan[5] in his excellent report of seven cases so treated. All other cases have been treated by combining intravenous with local serum injections. The routine has been to give 40 c.c. intravenously and 10 c.c. locally every four hours, treatment being started on diagnosis and coincident with the initial blood culture. A desensitizing dose preceded all injections. Our inclination now is to consider every case a septicæmia at the outset and to give one or two massive doses intravenously until blood culture proves definitely negative (twenty-four hours). Treatment should be intensive at the outset, gradually diminishing after forty-eight hours or on negative culture, rather than the opposite. Serum reactions have been present in practically all cases whether serum dosage was small or large; in no case was serum thought to be related to a fatal termination.

Regarding operation on the lesion in these cases, it seems fair to assert that surgery has no place here if serum is available. In fact it is open to grave question whether it has any place in this disease even without available serum. It has been shown by His and Zinsser[6] that immediate excision of the site of inoculation in guinea pigs fails to check the spread of the infection; abundant statistics are available to show a higher mortality with the use of surgery than without. That this conclusion conforms to the pathological conditions as well is borne out by the observations of the pathologists that the swelling in these cases is due to the presence of a semigelatinous substance, anthraco-mucin, which is inimical to the growth of the anthrax bacillus and which represents, therefore, a defense reaction on the part of the tissues, and should be left alone.[7]

Symmers, as a result of considerable experience with the serum treatment of anthrax in human beings, believes that every such lesion of the skin or elsewhere should be tentatively regarded as attended by generalized infection, until the result of the blood culture proves the contrary, and that in no circumstances is it justifiable to incise, excise, cauterize or otherwise tamper with the anthrax pustule, since septicæmia may result. According to this observer, the most dependable routine method in the treatment of the anthrax pustule is, first, to isolate it within a barrier of anti-anthrax serum subcutaneously injected every four hours; second, to inject intravenously at once a sterilizing dose of 150 or 200 c.c. of serum, and, third, to supplement this

by the intravenous injection of 40 c.c. every four hours. If the blood culture is negative at the end of twenty-four hours, the intravenous use of serum is discontinued, the local injections being kept up until the pustule is free from bacilli or at least until involution forms occur in the stained films. In anthrax septicæmia, the same routine is followed until the blood cultures are negative or until death supervenes.[8]

SUMMARY

Thirty-seven cases of anthrax are reviewed.

This disease tends toward a septicæmia from the local lesion.

Specific serum offers a very fair prognosis.

Its use should be intensive, both intravenous and local, at the outset.

Surgery has no place in the treatment of the lesion. Its use may be directly harmful.

BIBLIOGRAPHY

[1] Hubbard, S. D.: Jour. A. M. A., vol. lxxv, p. 1687, December 18, 1920.

[2] Hubbard, S. D., and Jacobson, W: Bulletin N. Y. Dept. of Health, November, 1920, p. 266, Sect. 230—Sanitary Code of New York Dept. of Health.

[3] Symmers, D.: ANNALS OF SURGERY, June, 1922, p. 663.

[4] Marchoux, E.: Serum Anti Charbonneux, Annales de l'Institute Pasteur, November, 1895, p. 800.

[5] Regan, J. C.: Amer. Jour. of Med. Sciences, September, 1921, p. 406.

[6] His and Zinsser: Text-book of Bact., N. Y., 1916, p. 571.

[7] Symmers, D.: ANNALS OF SURGERY, June, 1922, p. 666.

[8] Symmers, D.: Personal Communication to Author, March 1, 1923.

THE OPERATIVE CURABILITY OF CARCINOMA OF THE STOMACH*

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A lesion which comprises about one-third of all instances of carcinoma, and which hitherto has been so insusceptible of successful treatment that it has been generally regarded by the medical and lay public as nearly hopeless, certainly deserves the most earnest study, in an endeavor to improve our results. Such a lesion is carcinoma of the stomach. While there is some variation in the reports from different clinics, it seems to be a conservative statement that taking into consideration both its frequency and its obstinacy, it is the chief single contributor to the total cancer mortality.

There appears to be no inherent reason why carcinoma of the stomach should present such a problem. Its natural history is presumably similar to that of carcinoma elsewhere. Disregarding for a moment its etiology we may say in accordance with prevailing views that its original focus is a cell or group of cells endowed with the fatal property of atypical and unregulated division and growth; that it increases at first by invasion of the tissues of the stomach itself, or of neighboring and adherent organs, and that at some variable and not to be predicted time, it further disseminates itself by cellular emboli in the lymph or venous blood streams. A fourth method of spread can only be possible in a hollow organ which lies free in a body cavity; namely, the breaking off of small cell masses from the parent growth and their implantation either at another point of the mucous membrane within the stomach or at various points in the peritoneal cavity outside the organ. If these accepted views are correct, surgical removal of the focus while still localized will cure the disease.

Anatomical and physiological considerations offer every encouragement to the belief that extirpation is possible. The stomach is accessible to attack, and especially the part between the incisura and the pylorus where, according to Welch's classical analysis of 1300 cases, about 70 per cent. of the lesions occur. The first relay of nodes receiving the lymph stream from this region lie along the borders of the viscus, between the layers of the gastro-hepatic and gastro-colic omenta, respectively, and are thus susceptible of removal. The blood supply is very rich, and there is a free intramural anastomosis between the lesser arterioles, so that the most extensive resection and elaborate restorative suturing can be carried out without fear of devitalizing what remains of the organ, a condition which contrasts sharply with the small intestine. The union of the proximal part of the stomach with the jejunum may be technically more or less difficult, depending on the extent of the resection, the adiposity of the patient and other factors, but it may usually be accomplished satisfactorily. The loss of the function of the stomach furnishes no insuper-

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able obstacle to operation. Here as in so many other instances Nature has been lavish in bestowing an excess margin of physiological efficiency, so that a large part or even the whole of the stomach may be sacrificed without seriously affecting the digestive function. Subtotal gastrectomy is commonly performed, and there are enough instances of the maintenance of health after a practically complete removal of the organ to justify the surgeon in being as radical as is made necessary by the extent of the lesion. The well-recognized rule that when one member of a physiologically related group of organs gradually becomes crippled by disease the other members may assume compensatory increase of efficiency is applicable here, for in some slowly developing forms of carcinoma, such as the scirrhous or "leather bottle" type, the stomach may be reduced to a mere tubular canal along which the food passes rapidly through a gaping pylorus, without the delay necessary for the exercise of the chemical or motor functions of the organ, which indeed have been destroyed by the disease. Such a patient may maintain a surprising degree of health, and the successful removal of the greater part of such a stomach may not affect seriously the digestive processes.

If these facts are admitted, why have the results of radical operation been so generally unsatisfactory? Perhaps it is because the disease is disseminated from the original focus at an earlier period than is the case with carcinoma in other situations. But the opinion that the disease may remain local for a long time seems to be justified by review of the history of certain cases which have come to operation or autopsy, and other cases where exceptional circumstances have given opportunity to follow the natural history of the disease. Two forms of dissemination will admittedly render a case incurable; that is implantations in the peritoneal cavity in cases where the disease has penetrated the visceral wall, and metastases to the liver by way of the portal blood stream. The first form can necessarily occur only in the comparatively late stages of the disease. Table I shows the incidence of metastases to the liver in cases occurring at the Peter Bent Brigham Hospital. Inasmuch as among the 67

TABLE I

Incidence of Metastases to the Liver in Carcinoma of the Stomach.

Among 67 operative cases, in which the condition of the liver could be observed, there were:	
Metastases present in	15, or 22.3 per cent.
Metastases absent in	52, or 77.7 per cent.
Among 22 non-operative cases coming to autopsy, the liver showed:	
Metastases present in	17, or 77.2 per cent.
Metastases absent in	5, or 22.8 per cent.

operative cases in this table, in only 23 could a radical operation be performed, in 29 of the remaining, or 43.2 per cent., the obstacle to such an attempt was not metastases in the liver, but rather the local extent of the disease or of its lymphatic dissemination. It is striking to note also that in cases which have died of carcinoma of the stomach, the liver was still not involved in 22.8 per cent.

The inevitable deduction from the foregoing considerations seems to be that the most formidable obstacle to success in the surgical treatment of carcinoma of the stomach lies in the delay of the patient in seeking surgical aid, and it is the common experience that this delay is occasioned by the insidious, stealthy course of the disease. Unless it begins close to the cardiac or pyloric orifice and thus interferes promptly with the entrance or exit of food, we cannot expect early symptoms. The great zone between these points may be designated as a silent area, where the lesion may exist and progress locally, gradually interfering with the chemical and motor functions, but so slowly as to permit of abundant compensation elsewhere. Striking symptoms, such as vomiting of blood or the passage of tarry stools, are late rather than early. Pain, which is frequently the first symptom complained of, does not characterize the growth of the tumor itself. The stomach does not possess nerves which respond to ordinary pain stimuli. It may be bruised, cut or cauterized in the non-anæsthetized patient without a sensation of pain, and it is presumably not until the progress of the disease causes adhesions to neighboring structures, or by interfering with the emptying of the organ increases intragastric tension during peristaltic tonus, that painful sensations result.

When the cause of a disease is well understood, a long step has been taken towards establishing an early diagnosis. The cause of carcinoma of the stomach is not yet known. The usually suggested factors apply here as elsewhere, such as fœtal rests, physical, chemical or thermal trauma and chronic irritation. It is the relation between chronic ulcer and carcinoma which is at present exciting most interest and discussion. That chronic gastric ulcer should undergo malignant metamorphosis is quite in accord with the behavior of similar lesions elsewhere. The most familiar and unquestioned examples of such a change are the epithelioma of the lower lip from irritation of the hot pipe stem, and of the tongue from the injury due to ragged and decayed teeth, or the malignant degeneration of chronic ulcer of the lacerated cervix uteri, or of varicose ulcer of the leg. The Rochester, Minnesota, School believe that they have shown carcinoma developing in the edge of a chronic ulcer in a large proportion of cases, and state that 60 per cent. of the operatively proved cases give an ulcer history. Smithies reduces the figure to 54 per cent., Graham to 40 per cent., and Friedenwald to 23 per cent. This view is widely held, but equally competent observers hold contrary views. For instance, Ewing states that it is his opinion that carcinoma is grafted on ulcer in about 2 to 3 per cent. of cases. The conflict of opinion on pathological evidence seems to depend on personal equation in the interpretation of the histological picture. The fact is that every chronic ulcer shows grossly a peripheral thickening and induration which suggests neoplasm, and microscopically, regeneration of glandular alveoli which may be so distorted and misplaced as to suggest malignant metamorphosis, while every carcinoma, as soon as its growth has outstripped its blood supply, necessarily ulcerates at the centre and presents a picture which may in some cases be confused, both grossly and microscopically, with ulcer.

The records of all cases of gastric carcinoma admitted to the Peter Bent Brigham Hospital in the ten years, 1913-1922, inclusive, have been examined with the idea of determining the actual outcome of treatment, and of studying the various factors which may lead to earlier diagnosis and more favorable results. Naturally, in only those cases which come to operation or autopsy could the diagnosis be certified. In most others the criteria for a positive diagnosis rested on a positive history, a mass in the epigastrium and a characteristic filling defect on röntgenological examination. In a few cases the absence of one of these was permitted, if other minor features were present, such as achlorhydria, hæmatemesis or evidence of blood in the stools. Any case affording reasonable doubt of the diagnosis was rejected. Lymphosarcoma and similar types of malignant disease have not been included.

TABLE II

Analysis of 236¼ Cases of Carcinoma of the Stomach.

Sex Incidence.

Sex	No. of cases	Per cent.
Male	157	66.5
Female	79	33.5

Age Incidence.

Age	No. of cases	Per cent.
21–30 incl.	2	0.8
31–40 incl.	20	8.4
41–50 incl.	58	24.5
51–60 incl.	84	35.5
61–70 incl.	60	25.4
71–80 incl.	12	5.0

TABLE III

Analysis of Symptoms First Complained of in 223 Cases of Carcinoma of the Stomach.

Symptoms	No. of cases	Per cent.
Epigastric pain	57	25.5
Epigastric distress after eating	43	19.2
Belching of gas	25	11.2
Weakness and debility	25	11.2
Loss of appetite	21	9.4
Nausea or vomiting	19	8.5
General abdominal pain	8	3.6
Loss of weight	4	1.7
Sour stomach	4	1.7
Constipation	4	1.7
Dysphagia	4	1.7
Pallor	3	1.3
Backache	3	1.3
Mass in epigastrium	2	0.8
Vomiting of blood	1	0.4

During this decade, 236 cases were found conforming to the above requirements. Table II gives the age and sex incidence. The preponderance of men over women is more striking than in most statistics. It illustrates also the well known fact that the diagnosis of carcinoma of the stomach must be

considered in patients under thirty, and is common between thirty and forty. Table III presents an analysis of the symptoms first complained of by the patient in 223 cases in which the history was satisfactory in this respect. It is quite in accord with general experience and presents nothing new, but deserves attention because only when it is realized by the laity and by the general practitioner that such symptoms are significant until proven otherwise may we expect to be consulted in time to operate with reasonable prospect of cure. It is worth noting that weakness and debility, general abdominal pain, loss of weight, constipation, pallor, and backache together constitute the initial symptoms in 20.8 per cent. of the cases, and if we add the 9.4 per cent. of patients complaining at first only of such a universal symptom as loss of appetite, we find that in 30 per cent. of the cases the earlier symptoms would not be likely to suggest to the patient that the stomach was the source.

TABLE IV

Analysis of Symptoms.

Incidence of Vomiting before Admission in 225 Cases.			
Vomiting occurred in	153 cases,	or 68	per cent.
No vomiting occurred in	72 cases,	or 32	per cent.
Blood or coffee grounds noted in	48 of 153 cases,	or 32.1	per cent.
No blood or coffee grounds noted in	104 of 153 cases,	or 67.9	per cent.
Forty-eight patients out of 225, or 21.3 per cent., complained of bloody or coffee grounds vomitus.			
Incidence of Blood in Stools before Admission.			
Tarry stools noted in 26 cases out of 236 cases,		or 11	per cent.

Vomiting is a symptom so objective and annoying that it is likely to be taken seriously by the patient, especially if the vomitus contains blood or such a peculiar looking substance as "coffee grounds," which resembles nothing that the patient has eaten. Table IV shows that although, as will be seen later, the type of cases admitted was so advanced that less than 10 per cent. could be subjected to radical operation, nevertheless 32 per cent. had had no vomiting whatever before admission, and among the cases which had vomited, only 32.1 per cent. had noted anything so unusual as blood or coffee grounds. Among the laity the impression is widely held that the vomiting of blood is necessary for a diagnosis of cancer of the stomach. Let it be noted then that in this series but 21.3 per cent. had had bloody or coffee grounds vomitus previous to admission. Tarry stools were noted in so few instances, 11 per cent., as not to constitute an important factor in early diagnosis.

Table V shows the duration of symptoms before admission. It should be read with two facts in mind; first, that the great majority of patients admitted showed the disease in too advanced a form to permit of radical operation, and second, that while the exact duration of a case of carcinoma of the stomach can never be known, there is plenty of direct evidence that in many cases the life history may be 5, 6, 7 years or more. Table V shows that 50 per cent. of the cases had had symptoms for only 6 months, and 80 per cent. for less than 1 year. In other words, if 80 per cent. of the patients presented

themselves at the very onset of symptoms and were at once successfully diagnosed, it is probable that only a small proportion would be found to be radically operable.

TABLE V

Duration of Symptoms Before Admission in 220 Cases.

Time	No. of cases	Per cent.
Less than 2 wks.	2	0.9
2 wks.–1 mo.	5	2.3
1–2 mos.	24	10.9
2–4 mos.	52	23.6
4–6 mos.	28	12.6
6–12 mos.	65	29.5
12–18 mos.	12	5.5
18–24 mos.	21	9.5
2–2½ yrs.	4	1.8
2½–3 yrs.	5	2.3
More than 3 yrs.	2	0.9

TABLE VI

Duration of Life in 97 Inoperable Cases Traced (Omitting Operative Fatalities).

Time	No. of cases	Per cent.
1 wk. or less	15	15.2
1–2 wks.	13	13.2
2–4 wks.	16	16.4
1–2 mos.	14	14.4
2–4 mos.	19	19.5
4 mos. or more	20	20.6

44.8 per cent. of this group lived 1 mo. or less
9.2 per cent. of this group lived 6 mos.

TABLE VII

Length of Life from Onset of Symptoms to Death in 83 Cases not Operated on.

Time	No. of cases	Per cent.
2 months or less	8	9.6
2–6 months	23	27.7
6–12 months	11	13.2
12–18 months	23	27.7
18 months or more	18	21.6

The standard of operability, in different clinics and in the hands of different surgeons, must vary to a certain extent, and the accurate comparison of statistics is therefore fallacious. Tables VI and VII will seem familiar to surgeons whose clinical material is drawn from large cities on the seaboard, where the large proportion of recent immigrants and the congestion of population make the level of intelligence relatively low. Table VI shows the duration of life from admission to the hospital in such cases as were considered inoperable and could be followed up. Cases explored and found inoperable were not included in order to eliminate the factor of operative trauma. It will

be seen that 44.8 per cent. lived less than one month, and only 9.2 per cent. lived 6 months or more. There can be no difference of opinion as to the inoperability of these cases. Table VII gives evidence on the same point, and also shows the extraordinary insidiousness of the disease. It shows that among 83 cases not operated on the total elapsed time from the onset of symptoms to death was, in nearly 40 per cent. of the cases, only 6 months or less. And this in a disease whose average duration is probably 4 years!

TABLE VIII

Relation of Ulcer to Carcinoma of the Stomach.

Ulcer history	No. of cases	Per cent.
Positive	18	7.6
Plausible	14	5.9
Possible	20	8.4
None	184	77.9

Pathological examination was reported to show carcinoma developing on ulcer in 4 cases in 46 cases coming to operation or autopsy, or 8.7 per cent.

The relation of a history of ulcer to carcinoma in the total of 236 cases appears in Table VIII. Here obviously the bias and judgment of the investigator must play a rôle. The types of histories classified under the heading "positive," "plausible," "possible," and "none" are indicated satisfactorily by these words. A patient who described in his antecedent history any symptoms however trivial which might be associated with gastric digestion was placed in the "possible" group, and only those who categorically denied abdominal pain, distress, indigestion, nausea, vomiting or belching of gas were considered to have no ulcer history. Certain cases giving a gastric history somewhat suggestive of ulcer of 3 years' duration which were found at operation to present an advanced carcinoma were considered to have been malignant from the beginning, because in the judgment of the operator the growth was consistent with that period of development. Under this classification, 7.6 per cent. were unequivocally positive. The two intermediate doubtful groups may doubtless be assigned according to the bias of the individual investigator. A bit of evidence from a different source exists in the report of the pathologist of carcinoma developing on ulcer in 4 instances among 46 cases which came to operation or autopsy; an occurrence percentage of 8.7, which corresponds rather strikingly to the 7.6 per cent. of positive ulcer histories. The relation between the presence of free hydrochloric acid and a history of ulcer does not appear intrinsically important. Seventy-three and nine-tenths per cent. of the cases showed achlorhydria; and of the remaining 26.1 per cent. showing the presence of hydrochloric acid, 13.9 per cent. gave a positive antecedent ulcer history.

In presenting a statement of the operability of the 236 cases under consideration, it is realized that there can be no just measure of its accuracy or fallibility. No two surgeons are alike in their judgment as to operability or

their skill in operating. Table IX represents the judgment of a small group of surgeons whose aim is not to permit the ideal of a low operative mortality to withhold from a patient any reasonable hope of cure. Table IX shows that 62.6 per cent. of all cases admitted had to be denied any possible hope of palliation or cure, while in only 9.7 per cent. was it considered feasible to attempt a radical operation. Among the 5 per cent. who refused treatment

TABLE IX

Analysis of Operability of 236 Cases.

Treatment	No. of cases	Per cent.
Inoperable for either exploration, palliation, or cure	124	52.5
Explored and found inoperable for either palliation or cure	24	10.1
Palliative operation for obstruction or perforation	53	22.4
Radical operation	23	9.7
Operation refused	12	5.0

TABLE X

Operative Mortality in 100 Cases.

Operation	No. of cases	No. of deaths.	Mortality per cent.
Exploration only	24	5	20.8
Palliative operation for obstruction or perforation	53	7	13.2
Radical operation	23	3	13.0

were a few who on exploration might have been added to this group. Two patients are remembered who suffered a possible miscarriage of treatment, which resulted in a palliative rather than any attempt at a radical procedure. Making due allowance for these instances, it seems to be a fair statement that in about 10 per cent. of all cases admitted to the hospital a radical cure could be attempted.

In Table X is tabulated the mortality in 100 cases subjected to some form of operation. Simple exploration showed the high hortality of 20 per cent., for which no apology is made. These cases were all obviously radically inoperable; the exploration was in most cases done under novocain anæsthesia with the idea of palliating the suffering of the terminal stage of the disease. The expediency of exploring will depend on the temperament and point of view of the surgeon and his patient. The latter is in a pitiable condition, regurgitating the liquids he tries to take to quench his thirst, dehydrated, kept alive by daily subcutaneous saline infusions and rectal alimentation. He may grasp at the possibility of relief for a few weeks by a simple palliation, at the expense of a high risk of more speedy termination of his suffering. The surgeon need not reproach himself if he is the agent of this relief, in whatever way it may come. The palliative operations for obstruction or perforation and the radical gastrectomies carried nearly the same mortality, about 13 per cent.

TABLE XI

Analysis of Operative Results.

Palliative Operations In 30 Cases Traced.

Lived	No. of cases	Per cent.
Less than 1 mo.	1	3.3
More than 4 mos.	22	73.3

Radical Operations In 20 Cases, All Traced.

Lived	No. of cases	Per cent.
Less than 12 mos.	4	20.0
1–1½ yrs.	6	30.0
2½–4 yrs.	2	10.0
7 yrs.	1	5.0
Still Living	7	35.0

Of the Seven Patients Still Living,

1 is alive at the end of 1 yr.
1 is alive at the end of 1½ yrs.
1 is alive at the end of 3 yrs.
1 is alive at the end of 4 yrs., 11 mos.
1 is alive at the end of 5 yrs., 10 mos.
1 is alive at the end of 6 yrs., 6 mos.
1 is alive at the end of 7 yrs., 9 mos.

Thus three cases, or 13.0 per cent. of operable cases, or 1.2 per cent. of all cases seen, show 5 year "cures."

Here are analyzed the end results of the palliative and radical operations. In regard to the former procedures, comparison may be made with Table VI, where it was shown that of patients not operated on 20.6 per cent. lived 4 months or more, while 73.3 per cent. of the patients afforded palliative operations lived a similar period. The two series are not exactly comparable, as the non-operated cases were on the average more advanced, but when considered also with reference to the relief afforded by gastro-enterostomy, it appears that attempts at palliation are abundantly justified.

In the case of the radical operations, it is fortunate that all have been traced. They are arranged in two groups, those who have died and those still living. The tabulation shows 13 per cent. of the radically operable cases living at the end of 5 years without evidence of recurrence; which is equivalent to 1.2 per cent. of all cases of carcinoma of the stomach seen at the Brigham Hospital. Another patient, living at the end of 4 years and 11 months, when this paper is written, may justly be included. Yet another, who lived 7 years, developing an apparently independent cancer of the breast and dying of spinal metastases without known local recurrence of the carcinoma of the stomach, would, if included, still further improve the statistics.

Such a record of failure to cure the most common type of malignant disease is regrettable, but the most discouraging feature is that it is difficult to see how any very great improvement may be achieved. Early diagnosis and prompt resort to surgery appear to be at present the only key to success, but if the

disease in most instances runs the greater part of its course so insidiously that the patient is quite oblivious of it, and if the first symptoms are apt to be so trivial as not to attract serious attention, it is unlikely that rapid progress can be made. It is desirable that both physicians and patients should pay less regard to the text-book picture of the disease in its fully developed stages, and should realize that any obscure symptom complex, however trivial, especially if it involves any change in the previous digestive habit of the individual, must be investigated and proved to have no malignant basis. Of methods of diagnosis, undoubtedly the most accurate by a wide margin are fluoroscopy and radiography after the ingestion of the opaque meal. In the series under consideration, 93 per cent. showed a pathognomonic picture leading to correct diagnosis, 3.5 per cent. were suggestive, and in only 3.5 per cent. was a negative report made. This period included the war, when owing to a changing and depleted staff, the work was not always satisfactory. It is likely that in experienced hands in the future an accurate positive diagnosis will be made in at least 97 per cent. of the cases.

Carcinoma of the stomach is curable by radical surgical operation, at the expense of a high but justifiable mortality. Success depends, as in most surgical conditions, on early diagnosis and prompt recourse to treatment.

ACUTE PERFORATION OF DUODENAL ULCER

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and

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The following report is based on ten consecutive cases of acute perforation of duodenal ulcers, admitted to the Receiving Hospital of Detroit during the past two years. Reference to cases of subacute and chronic perforation is purposely omitted. We shall give a résumé of the history, examination, operative finding, immediate outcome, and will, of necessity, defer including the ultimate result.

Of the ten cases, nine were male and one was female. Their occupations were given as laborer (2), not employed (2), farmer (1), housewife (1), engineer (1), clerk (1), miner (1), watchman (1); in nationality, American (5), Scotch (3), Irish (1), Hebrew (1). The average age was thirty-eight and one-half years; the oldest being fifty-six, and the youngest nineteen.

Six cases had a typical history of chronic ulcer, the average duration of which was seven years. Two gave indefinite reports of recent indigestion, of five and seven days, respectively. Two presented no previous history of ulcer whatsoever, their first symptoms being sudden agonizing upper abdominal pain. Of those having had symptoms of chronic ulcer, only one reported hæmatemesis and malæna. The majority had had post-prandial pain, acid eructation, pyrosis, vomiting, belching, and pain relieved either by emptying the stomach or by the ingestion of more food.

In regard to predisposing causes, practically all of the series had focal infections of various grades of severity. Several had had appendicitis and one had had his appendix removed with the hope of relieving indigestion. Tonsillitis, quinsy, influenza, and pneumonia were given among the previous diseases. The Wassermann reaction was positive in but one case. Nothing definite could be deduced in regard to alcohol, tobacco and other remote predisposing factors. One patient, however, said he had been drinking almost constantly for two weeks and when admitted, following perforation, was afraid he would be considered as merely inebriated. Direct trauma was the suspected activating cause of the rupture in the last case.

In all but one the attack was initiated by sudden exceedingly severe upper abdominal pain. This exceptional case had premonitory vomiting of blood fifteen minutes before the pain appeared, although it is to be noted that no demonstrable blood was found in the abdomen at operation. Pain remained a constant symptom in all but one, the so-called intermittent period or lull with complete cessation of pain being absent in all others.

The symptoms of nausea after the onset of the acute condition was present in one-half of the series, and was more frequent in the cases showing the soft, small type of recent ulceration. One-half had vomiting of recently ingested food between the onset of the acute trouble and the operation. Two had regurgitation of nearly clear fluid and had recurring attacks of severe retching. Three had no vomiting or retching. Intense thirst and request for water was common to all.

At examination, all tended to guard and steady the abdomen by flexed knees or folded forearms and a position once assumed was rarely changed. While all were prostrated, two patients were noteworthy for recurrent attacks at fairly long intervals marked by restlessness and constant change of posture. In both of them intense pain was the first symptom, but uncommonly enough this pain tended to be intermittent in character. They were both observed very shortly after the onset of the acute attack and were the only cases to show even a slight degree of shock. At operation both presented small perforations in soft ulcers of the recent variety. While all of them were "knocked out," nothing uniform was determined about the appearance of the face, the presence of sweat or the expression about the eyes. None requested alcohol, a diagnostic point occasionally emphasized. The great majority resented examination, objected to the effort of moving about and of articulation, and begged for relief from their distress.

While some abdominal distention was present in four instances, the only one to show marked general distention was a case where four days had elapsed after the onset of the acute condition. All but one presented definite auscultatory peristalsis, and in all, general tenderness was present and more marked in the epigastric region, but in only one was it definitely localized over the duodenal area. Board-like rigidity was present in all except a four-day case, but inconstant in two others; each of the latter had a small perforation of a minute non-calloused ulcer and rigidity was unexplainably intermittent. The only one to present generalized advanced peripheral peritonitis was a fatal four-day case. This, too, was one of two patients in the series to exhibit pelvic tenderness. Tympany in some degree was present in all and obliteration of the liver dulness, while not pathognomonic of perforation of the duodenum or, indeed, of any hollow viscus, was observed in seven cases. Emphysema of the abdominal wall was not encountered.

The pre-operative temperature was notable because of a uniform subnormal finding, the average being 97.7 degrees. The average pulse on examination was 88. There was a slight increased respiratory rate, but this was not marked. Two cases exhibited definite diaphragmatic irritability as evidenced by short, catchy respirations. The white count was generally increased, the longer the time elapsing between onset and examination the higher being the total count.

In all but one of the series our pre-operative diagnosis proved, on laparotomy, to be correct. The one mistake was made in the four-day case, the one

female in the series, in which the history, from the onset, pointed somewhat to the pelvis. Gastric ulcer perforation and appendicitis were the reserve diagnosis in two cases. The average time between perforation and operation was fifteen and a half hours. Omitting the four-day case, the interval was six and a half hours for the remaining nine. In discussing the signs, symptoms and results in this report, our good fortune in securing these cases early must be commented upon.

The gross pathological diagnosis of the ulcer exposed on laparotomy was four of the small, soft, recent type and six of the hard, chronic, calloused variety. None of the former had a previous history of ulcer, while all of the latter did; thus, the pathology and the history coincided. In no case was multiple perforation found; no contact or multiple ulcers were observed. In every case the position of the ulcer was within one inch of the pyloric vein. Four were situated directly on the anterior aspect of the first part of the duodenum, four were on the superior margin, and two were on the intermediate antero-superior position. None were present in the inferior or posterior surfaces. The diameter of the ruptured area varied between 2 mm. and 1 cm., the majority being of the smaller size. All of the perforations, including the one possibly burst through by direct trauma, were rounded, punched out and had smooth edges. Adhesions about the ulcerated area were not present in any instance. In none was there active bleeding from the ulcer. Gas was escaping and duodenal fluid was leaking from all; in all cases the abdominal cavity contained varying amounts of clear, turbid or mucoid fluid, while in none were demonstrable food particles. Even in the two cases who were restless, as in acute appendicitis or as in inflammatory or calculus involvement of either the biliary or the upper urinary tracts, no evident difference in the character of the extruded material could be noted. One each presented definite injection of the peritoneum and diffuse purulent peritonitis and needless to remark, both of them came to operation late. But a single case was noticeable for obstructed pylorus. No coloring matter, such as methylene blue, was given by mouth to aid in locating the perforation. This would seem quite unnecessary. A tentative diagnosis of rupture contraindicated pre-operative stomach lavage.

The various operative precedures employed were: simple closure of the perforation and reinforcement with additional sutures (2 cases), excision of ulcer with modified pyloroplasty (1 case), enterorrhaphy with gastro-jejunostomy (5 cases), excision and closure of ulcer and gastro-jejunostomy (2 cases). In all but two cases, advantage was taken of neighboring gastro-hepatic omental tabs to reinforce the sutured area. Of the two fatal cases, one had simple closure of the perforation while the other had both infolding plus posterior gastro-jejunostomy. Three operations were completed by removal of the appendix. In none were adhesions of any great importance or involved gall-bladders found. All were drained by a single drain through a suprapubic stab wound; one had an additional drain into the region of the right kidney

pouch, while none had drainage to the various suture anastomoses or through the laparotomy incision.

The post-operative care of all was the accepted expectant treatment for peritonitis; elevation of the head of the bed, administration of an adequate amount of morphine, application of external heat, and large quantities of fluid by rectal, intravenous, and subcutaneous routes. As soon as water was tolerated by mouth it was forced. Fluid diet was started the second or third day, after which soft diet of the bland variety was increased and continued. All drains were removed within a seventy-two hour period.

Of the total number of ten cases observed, eight (80 per cent.) were discharged from the hospital recovered, and two (20 per cent.) died. Perforation of an old chronic ulcer occurred in both fatal cases. The one female patient in the list came to operation four days after the acute perforation, and expired on the table. She had an ulcer history of eight years' duration and, at laparotomy, presented extensive peritonitis with multiple scattered abscesses. No definite attempt to close the perforation by nature was found. Contemplating the findings, this case would fall among the complications of acute perforation. The other fatal case came to operation nine hours after perforation and had a history of ulcer trouble for seven years previously. Curiously enough, this was the only patient in the series who had received any proper anti-ulcer treatment, and this was in active process at the time of perforation. The average duration of stay in the hospital of the remainder was twenty-two days. (Table I.)

These findings are presented for the purpose of adding to the reported number of these relatively infrequent cases. We believe that the diagnosis is essentially clinical, the observed findings being of far greater value in the time permitted than all laboratory examinations. The determination of acute perforation is usually a simple matter, as certain symptoms are sufficiently distinctive and sequential to make it positive. To be confronted with an individual, and usually a male, making every mental and physical effort to obtain relief from a sudden, intensely severe, fairly constant, almost unbearable abdominal pain, and showing rigidity, only to be expressed as board-like, is highly indicative of perforation of an hollow viscus. But adding to this, a history of previous gastric disturbance, plus certain fairly constant clinical findings, a definite diagnosis can be arrived at. However, it must be noted in the occasional case the picture while being that of an acute abdominal crisis, is not clear enough to establish a definite clinical opinion. Seen shortly after acute perforation, the appearance of the patient may be deceiving. On inspection, shock and collapse seem apparent, but true surgical shock according to the accepted definition, which includes a rapid thready pulse and an evident fall in blood pressure is surprisingly absent. Instead, however, the majority of cases show a pulse of strong, full type and slow rate, as well as no distinguishing change in the blood pressure. Furthermore, at the onset the peritoneum appears to be fairly resistant to the outpouring of gastric contents

TABLE I.

Hospital number	Sex	Age	Past history ulcer	Pre-operative interval after rupture	Pain	Rigidity	Shock	Obliteration liver dulness	Gross pathology of ulcer	Operation	Result	Remarks.
10340-A	Male	36	2 years	5 hours	Constant	Constant	None	Yes	Hard	Duodenorrhaphy and gastro-jejunostomy	Recovered	
11318-A	Male	33	4 years	4 hours	Constant	Constant	None	Not stated	Hard	Duodenorrhaphy and gastro-jejunostomy	Recovered	
675-B	Male	46	7 years	9 hours	Constant	Constant	None	Yes	Hard	Duodenorrhaphy and gastro-jejunostomy	Died	Syphilis and myocarditis.
974-B	Male	27	5 days	5 hours	Constant	Constant	None	Yes	Soft	Excision ulcer and pyloroplasty	Recovered	
2205-B	Male	43	7 years	5 hours	Constant	Constant	None	Yes	Hard	Duodenorrhaphy and gastro-jejunostomy	Recovered	
720-B	Female	50	8 years	4 days	Constant general pelvic	Constant	None	Yes	Hard	Duodenorrhaphy	Died	On table. Purulent peritonitis.
9540-A	Male	40	None	5 hours	Intermittent	Intermittent	Mild	Yes	Soft	Excision ulcer and gastro-jejunostomy	Recovered	
7923-B	Male	19	7 days	5 hours	Intermittent	Intermittent	Mild	Yes	Soft	Duodenorrhaphy and gastro-jejunostomy	Recovered	
10481-B	Male	35	15 years	1½ hours	Constant	Constant	None	Yes	Hard	Excision ulcer and gastro-jejunostomy	Recovered	
10485-B	Male	56	None	14 hours	Constant	Constant	None	Yes	Soft	Duodenorrhaphy	Recovered	Exciting cause. Traumatic.

for some hours. Profound shock and rising peritonitis will soon follow when an immense amount of exceedingly toxic gastric material has escaped through a large perforation. Therefore, the early appearance must be disregarded and immediate surgical intervention be instituted in order that the advancement of insurmountable difficulties be prevented.

The walls of the duodenum may perforate acutely by an ulcerating defect in the base of an old-established ulcer or by a rapid, acute ulcerative process. Following the occurrence of rupture it may be almost impossible to differentiate clinically between the two types, except by the history. An history of long disturbed gastric function prior to perforation is indicative of ulceration through the thinned out base of a chronic, calloused, established ulcer, while the small, soft, recent, necrotic, or embolic ulcer may first make its presence known by sudden rupture. Some differences may appear in the cardinal symptoms immediately subsequent to perforation which may further serve to distinguish between the two types. Two of our cases are noteworthy because pain, rigidity and restlessness were intermittent instead of being constant in character. Small soft-walled perforations were present in both.

Considerable discussion has arisen of late in regard to the extent of the surgery necessary for the relief of these cases, and numerous are the procedures advised by various advocates. We believe that the character and location of the perforated lesion and the general condition of the patient are the important factors in determining the proper surgical therapy. That immediate closure of the perforation is essential, whether the lesion has occurred primarily or as a complication of an old ulcer, is self evident. The general condition of the patient and the local findings will determine the advisability of any additional procedures. Insecure suturing of the defect will call for omental support, while insufficient closure or a lumen too greatly narrowed by operative technic or by extensive involvement of the previous ulcerative process may demand relief by gastro-enterostomy. Inclusive excision of the induration surrounding the perforation, followed by a modified pyloroplasty, has the distinct advantage of removing the entire diseased area. Likewise the same result may be claimed for primary sleeve resection of the ulcer-bearing area, but rarely will the condition of the patient following perforation permit of such radical treatment. Frequently, progress is more sure when the operative therapy is applied in the successive steps of the multiple stage operation.

CONCLUSIONS

Perforation of the duodenum, whether simple or as sequence to chronic ulcer, is a condition uniformly susceptible to cure by immediately instituted surgical means.

Two types of duodenal ulcer may perforate; the large, calloused, chronic variety, and the small, soft, recent type. A positive history of previous ulcer will aid in diagnosticating the former, while the findings of acute rupture are usually, not always, the inaugurating symptoms in the latter.

The early symptoms of rupture are fairly uniform and are the typical findings in upper intra-abdominal hollow viscus perforation. However, pain, rigidity, and restlessness may occasionally be intermittent rather than constant; soft ulcers exhibiting more frequently the intermittent factor than do hard ulcers. History alone may indicate the perforating organ or may be of doubtful value. A differential diagnosis is not of practical value, for the treatment is the same.

Immediate closure of the perforation is the prime essential in the surgical treatment. The desirability of additional procedures depends on the local findings and on the general condition of the patient at the time. Excision of the ulcer, modified pyloroplasty, gastro-enterostomy and their combination, each has its indication. More extensive surgery is rarely advisable. Our results having been equally satisfactory with the various methods used, we state no preference, preferring to individualize.

Careful attention to diet is of great importance early as well as long after the operation.

Preëminently, the immediate results depend less on the type of surgical therapy employed than on the time interval allowed to elapse between the perforation of the ulcer and its proper surgical treatment.

ACUTE INTUSSUSCEPTION IN INFANTS*

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In this article I shall limit myself to a consideration of my experience in acute intussusception in infants twelve months of age or less. My series comprises fifty-one operations on fifty patients, with an operative mortality of 15 or 30 per cent. My experience in older children is limited to two patients with one death. In both instances the intussusception occurred during a severe attack of ileo-colitis. These patients were all operated on by me at the Babies' Hospital, on the service of Dr. Wm. A. Downes, to whom I am indebted for the privilege of operating.

Much attention has been directed in the past fifteen years to the symptoms and treatment of acute intussusception in infants. Many excellent articles have appeared in the literature establishing the fact that the proper treatment of the condition is operative, that the operative mortality is directly proportional to the duration of the symptoms and that, in the great majority of cases, if reasonable care is observed, the diagnosis may be made within twelve to twenty-four hours. Apparently it is necessary to go to Australia to find a community where the early diagnosis of acute intussusception is the rule. C. P. B. Clubbe,[1] of Sydney, Australia, in an excellent monograph based on his experience since 1893, reports 270 cases of acute intussusception, with a mortality of 20 per cent. Of these cases 88.5 per cent. were twelve months old or less. There is included in this report a consecutive series of 100 operations with a mortality of 7 per cent. P. L. Hipsley,[2] of the same city, reports fifty-one operations with a mortality of four, or 8 per cent. When I compare these figures with my own and with the statistics of other operators, here and abroad, I cannot but be impressed by the fact that our present mortality in this condition is too high. Strictly speaking, the mortality, while classed as operative, is not the mortality of the surgeon operating, but of the medical community which he serves. In no other condition, with which I am familiar, is the result of operation so directly dependent upon the prompt diagnosis of the family physician.

Acute intussusception is the most frequent abdominal emergency in infants. Approximately 75 per cent. of all acute intussusceptions occur in infants twelve months old or less and at least 50 per cent. in the period from five to nine months. Males always predominate, the ratio being about two to one. Among my patients there were thirty-one males and nineteen females. The youngest patient was five weeks old, the oldest twelve months. Twenty-seven were in the period between five and nine months.

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The nomenclature has suffered from an unnecessary exuberance of terms, and it is rare indeed to find two authors in entire agreement as to terminology. There is no reason for designating every possible variety of intussusception by some separate name. The list would be endless and would serve no useful purpose. The classification used by Clubbe [3] seems entirely practical, and I have adopted it in my series. He recognizes four types: Ileocæcal, entero-colic, enteric and colic. In the ileocæcal type are included both the form in which the head of the cæcum is the last part of the intussusception to unfold and that in which the ileocæcal valve forms the apex, the former being but a variant of the latter.[4] Included in the entero-colic type are two forms. In one, an intussusception, beginning in the ileum, near the valve, goes through the valve and increases at the expense of the cæcum and colon. In the other, the intussusception begins in the ileum, but when it reaches the valve it does not pass through, but pushes the valve before it, and increases at the expense of the cæcum and colon. In the former, when the cæcum has been completely unfolded, there remains a mass within the cæcum. In the latter, when the cæcum is being unfolded, an enteric intussusception is seen to emerge, and when the cæcum is quite unfolded it is found to be empty. Entero-colic intussusceptions, therefore, are really double, the "compound intussusception" of some authors, and in my opinion, are much more frequent in occurrence than is generally supposed, a fact which was emphasized by Cuthbert Wallace.[5]

The terms enteric and colic are self-explanatory. In the former group is included the form sometimes termed the ileo-colic, in which a small amount of the ileum is found in the cæcum, without any infolding of the cæcum or involvement of the appendix. To this simple classification into four types, there must be added the very rare forms taking origin in inversion of the appendix or a Meckel's diverticulum; the jejuno-gastric, a form which will rarely if ever be encountered in infancy, and the retrograde. Retrograde intussusceptions are those in which the lower portion of the intestine is invaginated into that above it. This form is quite commonly met with in the post-mortem room, the so-called agonal intussusception, but it is rarely seen during life.

All authors agree that the region of the ileocæcal valve is involved most frequently in this condition. In my series there were twenty-six ileocæcal, nineteen entero-colic, five enteric (including three so-called ileo-colic forms). In one enteric intussusception an inverted Meckel's diverticulum formed the origin. In one of the ileocæcal type, a small mucous cyst formed the apex. There was only one colic form encountered and this involved the ascending colon, just distal to a small ileocæcal intussusception, in the only instance of multiple intussusception which I have met with. In one case the type was not noted.

There is probably no single definite cause producing invagination of the intestine. Many theories have been advanced, none of which completely satisfies all conditions. It is reasonable to assume that the great mobility

of the lower ileum, cæcum and ascending colon in early life is a predisposing cause. It is also generally acknowledged that the bowel is more irritable and that its muscular action is less well coördinated than in later life, both of which factors may tend to produce invaginations. Undoubtedly perverted peristalsis is one of the ways in which an intussusception may arise. While abnormal conditions of the gut-wall and new-growths do excite the formation of intussusceptions, such forms are very rare in infancy. In an excellent article Perrin and Lindsay [6] formulate a theory to account for the majority of intussusceptions which they briefly recapitulate as follows:

1. "The determining factor is the production of the equivalent of a foreign body within the intestines. The foreign body is provided by the swelling of the preëxisting lymphoid tissue. The anatomical and age distribution of the lymphoid tissue in the alimentary canal agrees exactly with the anatomical and age distribution of intussusceptions."

2. "The factor that provokes this swelling is some gastro-intestinal disturbance. The secondary maximal incidence which occurs between five and nine months is accounted for by this."

Injudicious feeding as a cause has been stressed by many authors. In most of my cases I was unable to elicit any history pointing to this, though I am confident that it existed fairly frequently. Among my patients forty-one were wholly breast-fed and nine were wholly or partly nourished on modified cow's milk. In only seven was there any history of previous intestinal disturbance. However, twenty-four, or almost 50 per cent., of my cases occurred during July, August and September.

The pathological changes in an intussusception are the result of compression of the vessels of the mesentery. The veins and lymphatics are blocked and become so distended that the walls give way and blood and lymph are poured into the wall of the intestine and onto its surface. The involved intestine becomes œdematous and infiltrated and it is this that makes reduction difficult and sometimes impossible. In very acute cases where the arterial supply is cut off, gangrene soon follows. In most articles, reference is made to adhesions and difficulty in reduction is ascribed to their presence. I have never noted the presence of adhesions in any of my cases. The surface of the bowel is often very ecchymotic and may be rough and granular. Even after resection of the invaginated gut, reduction may be impossible, but in my experience, this has always been due to the œdema and infiltration. While in a general way the extent of the pathological changes is determined by the duration of the condition, yet there may be great individual variation. For instance, in two of my cases giving identical pathological findings, one gave a clear history of twenty-four hours' duration and the other of six days. The former died, while the latter recovered, after a stormy convalescence. Obstruction is not always complete and the passage of flatus and fæces does not always militate against the diagnosis of intussusception. In the beginning the severity of the symptoms depends upon the degree of interference with the circulation, rather than upon obstruction of the bowel. Later the symp-

toms of obstruction appear with distention, toxæmia and fecal vomiting. In symptomatology, it seems to me desirable to divide intussusception into two classes. The first comprises the great majority of the cases, and it is in this group particularly, that we may hope to reduce the mortality by early diagnosis. In most cases in this group the diagnosis should be made from the history. There is no clinical picture more definite than the typical intussusception and I wish to emphasize the fact that the typical intussusception is the usual intussusception. A previously healthy, well-nourished, breast-fed baby screams while nursing or passing a stool, turns pale, vomits, recovers in a short time only to cry again and draw up his legs as if in pain. Shortly after the attack one or more normal stools may be passed and within a few hours blood, blood and mucus, or both mixed with fæces, will be passed per rectum. At this stage, save during the paroxysm of pain, the child may not look ill and there is usually no rise in pulse or temperature. This is a very important point, for many times it is hard to persuade the onlooker, that a child can have such a serious condition and yet appear so well. The infant usually refuses to nurse, but that is not necessarily so. There are, of course, some cases not so typical. The child may only appear fretful, may not even vomit and the mother's attention is first drawn to the condition by the bloody stool. Very occasionally there is no history suggesting an intussusception, as in the following case. A bottle-fed, seven months' old, female infant, had a nasal discharge and cough for four days. Two days ago was constipated and was given castor oil, with good result. This morning the baby started to cough and almost choked. A doctor was summoned and sent the baby into the hospital with a diagnosis of pneumonia. On routine examination by the resident, a rounded mass was made out in the epigastrium and a few minutes later the baby passed a stool containing blood. I was called and operated, easily reducing an entero-colic intussusception.

The other group is much smaller, comprising seven of my series, and consists of those intussusceptions occurring during an attack of ileo-colitis. While this is an unusual occurrence, it is sufficiently frequent to make it very desirable to keep the possibility in mind. The onset during ileo-colitis may be very acute, with all the classical symptoms. More often it is insidious and even after diagnosis is made, the duration of the invagination is often in doubt. In this class of patients the tumor is the most valuable, and may be the only diagnostic sign. The diagnosis is often exceedingly difficult and I am under the impression that intussusception as a complication of ileo-colitis is rather more frequent than is generally believed. It is fortunate that this group of cases is relatively small, for not only will the diagnosis be made late in a certain number of cases, but even if the condition is recognized early, the intussusception is merely an incident in a disease which has a high mortality of its own.

A physical examination should of course be carefully carried out in every instance, though in the majority of cases it is of secondary importance to the history. Usually an abdominal tumor may be made out, and certainly its

absence cannot be asserted unless an examination under anæsthesia has been made. In forty-six of my patients I was able to demonstrate a tumor. In four the distention was so great that it was impossible to define a mass. In one there was a small mass under the liver which I could not make out. An abdominal tumor is by no means essential to the diagnosis. The mass has been described as "sausage-shaped." Sometimes it is, but frequently it is rounded. It may be made out in any part of the abdomen, though usually, in early cases, it is found on the right side or in the epigastrium. In late cases, it is usually found on the left side. In three of my patients there was incomplete rotation of the colon, a fact which naturally influenced the position of the tumor. In fifteen patients I made out a tumor by rectal examination. This examination should always be made, but more often than not affords little information. Blood, blood and mucus, and rarely blood mixed with fæces, was noted in all but one of this series.

Ulcerative colitis and Henoch's purpura may be confused with intussusception. In the former the stools contain fecal matter, whereas in intussusception they are usually composed of blood and mucus. In certain instances in colitis, the mesocolon is thickened and may suggest a tumor, but as Clubbe [7] points out, this mass is longer and less definite and can never be felt in the rectum. Henoch's purpura rarely occurs in children under three years. The symptoms are purpuric spots, swelling of the joints, abdominal pains, intestinal hemorrhage and vomiting. Unfortunately the abdominal symptoms may precede those of the purpura. Hugh Lett [8] records a case of Henoch's purpura complicated by the presence of two separate intussusceptions occurring at intervals of seven days. The patient was three years old. Another author refers to a case of Henoch's purpura in which the diagnosis of complicating intussusception was apparently confirmed by the presence of an abdominal mass. At operation, the mass was found to be a hemorrhage in the wall of the intestine. In spite of this finding the presence of a mass in the abdomen in a patient suffering from purpura and with symptoms suggesting intestinal obstruction, is sufficient indication for a laparotomy. I have recently operated upon an infant of eight months in whom the diagnosis was in doubt. There was a mass across the epigastrium which was not unlike that of an intussusception. The history, however, was not suggestive of this condition. The operation revealed an acute pancreatitis. As a matter of fact the diagnosis is usually clear, and it is in those patients in whom an intussusception is intercurrent in an attack of ileo-colitis that the greatest difficulty will arise. I have never had occasion to use the Röntgen-ray, but in a doubtful case the possibility of its use should be borne in mind.

In my opinion the treatment should be laparotomy, carried out at the earliest possible moment. There is no indication for the employment of aero-hydrostatic methods, save in cases where the services of a surgeon are not available.

In my series the duration of the symptoms varied from six hours to six days. The average duration in those that lived was twenty-eight hours; in

those that died sixty hours. No patient was lost in whom symptoms had existed for less than twenty-four hours.

There were fifteen deaths. Five followed resection. In all of these the involved gut was gangrenous and in three reduction was impossible. One followed excision of a small inverted Meckel's diverticulum. In one infant in extremis and greatly distended, a palliative ileostomy under local anæsthesia was the only operation. There was one death on the tenth day from a perforating ulcer of the ascending colon, at the site of an injury sustained during a difficult reduction. In retrospect, the tear in the peritoneum should have been sutured with fine silk and a free graft of omentum applied. One patient died on the table, during operation under local anæsthesia. Five infants died within a few hours after operation, apparently from shock and toxæmia. One, removed against advice, died the next day.

As to Technic.—If there has been vomiting, and in any case with distention, the stomach is washed out preliminary to anæsthesia. The operative field is prepared with one-half strength tincture of iodine. Great care is observed to prevent the loss of body heat. Ether anæsthesia by the open drop method is preferred. Very rarely there is indication for local anæsthesia. The incision is a generous one, through the inner third of the right rectus, with the mid-point slightly below the umbilicus. Where there is a tendency to prolapse of distended intestine, I have found it wiser to disregard it and to complete the operation as rapidly as possible. An attempt is made to reduce the intussusception intra-abdominally until the ascending colon is reached, when the mass is delivered and reduction completed under the eye of the operator. In certain instances where the reduction is difficult, it may be desirable to deliver the mass even while it is in the descending colon. It will be necessary to replace it, however, when the splenic and hepatic flexures are reached. The reduction should be carried out by squeezing from below upward and expressing the intussusceptum from its sheath. This manœuvre should, if possible, be accomplished by the gloved fingers alone, without the aid of gauze, to avoid injurious pressure. When the reduction is difficult, I have been aided by grasping the mass and attempting to reduce the œdema by gentle pressure. Occasionally it is permissible to pull gently upon the entering loop, rather to direct the expulsion of the mass in the proper axis than to exert traction. As suggested by Dow,[9] I have at times introduced a sponge forceps between the entering and returning layers at the neck and gently separated the blades. In one form of the entero-colic type, it is important to remember the course of the invagination. In this form, the intussusception has gone through the valve, and after the cæcum is unfolded a mass can still be felt in the cæcum. To effect the reduction of this mass, it is desirable to exert pressure so that the intussusceptum will be directed out through the valve in the axis of the ileum. If pressure is exerted in the axis of the ascending colon and cæcum, the reduction may not be effected. It is important to "iron out" the little dimple which usually forms the apex of the intussusception. No attempt should be made to anchor the cæcum.

In three cases, however, where there was little reaction in the intestine after the easy reduction of ileocæcal intussusceptions, I have paralleled the ileum and ascending colon just above the valve, by means of three or four interrupted silk sutures, as suggested by Cubbins.[10] I have so far had no occasion to remove the appendix. If an inverted or gangrenous appendix be encountered, an appendectomy should be carried out, but not otherwise. One of the reasons advanced for a routine appendectomy is the prevention of recurrence. There are at least two cases [11, 12] on record where recurrence occurred, in which appendectomy had been done at the original operation.

Resection is avoided wherever possible, and I have been repeatedly impressed by the recuperative power of apparently badly damaged gut. In performing resection, axial anastomosis is preferred. In one patient a two-stage resection was attempted, but the child died shortly after the preliminary operation. Clubbe [13] reports a successful result with a two-stage operation in a six months' old infant. This method should receive consideration in desperate cases. Since Peterson [14] reported the first successful resection for gangrenous intussusception in an infant, quite a number of such cases have appeared in the literature. The most notable is that of Dowd,[15] who successfully resected an irreducible intussusception in a five days' old infant.

In one instance I did an ileostomy four days after reduction, where vomiting and distention persisted, apparently due to paralytic ileus. In this patient the duration of the symptoms prior to operation was six days. The result was successful. It is my intention, in the future, to use ileostomy more frequently in patients where the distention is marked.

Among my patients there was one recurrence in a child of eleven months, five months after operation for the original intussusception. Both were of the ileocæcal type. There are many instances of recurrence noted in the literature, but relative to the total number of cases of intussusception, it must be quite rare.

Spontaneous reduction does occur. I have operated on one patient in whom the lower ileum and cæcum bore obvious evidence of a reduced invagination. The possibility of spontaneous reduction should, of course, have no bearing on the treatment of the condition.

The closure of the wound is a very important part of the operation and should be carried out in layers, with painstaking care. Drainage is not desirable. Two instances of post-operative separation of the wound were encountered in this series. Both patients recovered.

The dressing is small and retained by long straps of adhesive. The post-operative treatment depends on the pathological changes in the gut. In the early cases it is very simple. For the first twelve hours we allow only water, then diluted breast-milk, in increasing amounts for thirty-six hours. On the third day breast-milk or the formula is allowed and by the fourth or fifth day the infant is back on his regular diet. We do not hesitate to give a hypodermoclysis of 3 per cent. glucose solution in amounts of 100 to 250 c.c.,

depending on the size of the child. This I believe to be a most valuable measure and may be carried out twice a day in dehydrated infants. If vomiting persists, the stomach is washed out. Pituitrin and enemata are given for distention. In any case a colon irrigation is given on the first post-operative day. When there has been much damage to the wall of the gut, there is a tendency to colitis and the post-operative feeding is very carefully watched. There is frequently a sharp post-operative rise of temperature, which usually subsides in thirty-six hours. The stay in the hospital is ten days in uncomplicated cases.

In spite of the high mortality for the series, I am somewhat encouraged by the fact that in the last seventeen consecutive cases there has only been one death, which followed resection in an eight months' old infant. This child lived eight days, dying of broncho-pneumonia.

Of the thirty-five patients surviving, I have been able to follow twenty-seven: two for five years; seven for two to three years; six for one to two years; twelve for less than one year. There were two deaths: one as a result of ileo-colitis two months post-operative; the other two years after operation of scarlet fever. There were two ventral hernias; one following a wound infection, occurring in a patient in whom there had been excision of an enteric cyst. This child has been followed for two years, and it is interesting to note that as the child has developed, the hernia has decreased in size, until now it can scarcely be demonstrated. This spontaneous cure of ventral hernia in growing children is a fact worthy of attention. The other hernia followed primary wound healing. This child was lost sight of after a few months. With the exception of these two complications and the two deaths, all the other children developed normally.

BIBLIOGRAPHY

[1] C. P. B. Clubbe: The Diagnosis and Treatment of Intussusception. Oxford University Press, London, 1921.

[2] P. L. Hipsley: Med. Jour. of Australia, vol. ii, No. 19, Nov. 9, 1918, p. 383.

[3] *Loc. cit.*, p. 22.

[4] D. C. L. Fitzwilliams: Lancet, Feb. 29, 1908, p. 632.

[5] Cuthbert Wallace: ANNALS OF SURGERY, vol. xli, March, 1905, p. 416.

[6] W. S. Perrin, and E. C. Lindsay: British Journal of Surgery, vol. ix, No. 33, July, 1921, p. 57.

[7] *Loc. cit.*, p. 38.

[8] Hugh Lett: Lancet, Feb. 20, 1909, p. 534.

[9] S. W. Dow: Lancet, June 8, 1918, p. 803.

[10] W. R. Cubbins: Surg., Gyn. and Obstet., vol. xx, No. 2, February, 1915, p. 177.

[11] A. Peskind: Am. Jour. Diseases of Children, vol. xiv, July, 1917, p. 63.

[12] Morris Cohen: Am. Jour. Diseases of Children, vol. xxi, April, 1921, p. 410.

[13] *Loc. cit.*, p. 69.

[14] C. W. Peterson: Medical Record, Mar. 4, 1905, p. 334.

[15] C. N. Dowd: ANNALS OF SURGERY, May, 1913, p. 713.

EXPERIMENTAL STUDY UPON THE USE OF INTRA-ABDOMINAL INJECTIONS OF HYPERTONIC GLUCOSE SOLUTION IN THE TREATMENT OF PERITONITIS

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There are two chief essentials in the treatment of acute free peritonitis: 1. To remove the source of infection, *i.e.*, the primary focus. 2. To combat the general infection and intoxication.

The first question belongs to the field of surgical technic and shall not be discussed here. Concerning the second question, it should be the aim of the therapy to aid the organism in its physiological methods of defense. How does the organism go about the reaction against an invasion of peritoneal cavity by bacteria? The organism protects itself from the spread of the germs in this way, after a short period of resorption the peritoneum produces exudate into the abdominal cavity. The organism sends liquid and solid elements to the battlefield; the exudate serves to dilute the toxins; by means of the transudation the leukocytes come into the peritoneal cavity where they bring about the action of phagocytosis. Murphy, Bordet and others [1] expressed the opinion that the danger of peritonitis is proportional to the absorption. Lennander [2] says: "The more abundant the secretion the better the prognosis." Thus the limitation of absorption and promotion of exudation are the methods of defense which the organism uses against the danger of general infection. We can assist these efforts of the organism by trying to repress the resorption and to increase the exudation.

Much experimental work has been done on this subject. The more important contributions in this field may be shortly reviewed.

In order to prevent absorption, Clairmont and Haberer [3] painted the diaphragm in animals with collodium. Other men with the same purpose used zinc paste. Glimm [4] experimented with pouring olive oil into the abdominal cavity. Pfannenstiehl and Hoehne,[5] Hirschel,[6] Krecke [7] and others report favorable results obtained by using camphor oil instead of olive oil. The camphor oil tends to limit only the absorption of bacteria which enter the lymph vessels, but not of the toxins which are resorbed by the blood-vessels. Another objection to the use of oil is the fact that several cases of oil emboli following this treatment were reported.

In the experiments of Schnitzler and Ewald,[8] glycerin proved to be a remedy which limits the absorption but is extremely dangerous. Exner [9] succeeded in retarding the absorption of toxins from the abdominal cavity by pouring adrenalin into it.

All of these methods proved unsatisfactory.

We experimented, therefore, with so-called osmotherapy which has been applied with great success in a wide variety of clinical conditions during the last fifteen years. We are indebted to van der Velden [10] for the introduction of this method. In 1909, he administered hypertonic salt solution intravenously to patients in cases of hemorrhages. Weed and McKibben [11] demonstrated that after injection of hypertonic salt solution the brain diminishes in size and cerebrospinal pressure decreases. Cushing and Foley,[12] Sachs and Belcher [13] applied this method to patients with cerebral herniæ and brain tumors with satisfactory results. Sansum [14] succeeded in reducing the intraocular tension in glaucoma by means of intravenous injections of hypertonic salt solution. Wells and Blankinship [15] report remarkable results in the treatment of influenzal pneumonia with the same method. Lichtfield [16] uses it in typhoid fever, meningitis and other serious infectious diseases, Erlanger,[17] to combat the traumatic shock. Von Noorden and Salomon,[18] Singer,[19] Gärtner and Beck [20] recommend it to check profuse diarrhœa in dysentery and cholera. Stejskal,[21] Lo Monaco,[22] Medeviélle [23] furnished the proof that intravenous injections of hypertonic solutions produce general inhibition of glandular secretion. Singer [24] reports that he succeeded in diminishing the night sweats of tuberculous patients, controlling hyperacidity of the stomach, profuse expectoration in asthma, tuberculosis and œdema of the lungs. Stejskal successfully limited the internal secretion of the thyroid gland; the goitres decreased in size and the thyrotoxic symptoms were not so pronounced. Wright [25] recommended " lymphlavage " of the wounds by means of dressings saturated with concentrated salt solution. Moynihan,[25] Rogge,[26] Stiede [27] used the same method and noticed an increase in secretion and a more rapid healing of the wounds. Strauss [28] combats uræmia by means of intravenous injections of 20 per cent. glucose solutions. Max Buerger and Hageman [29] spoke of a mobilization of œdema by means of osmotherapy. No harmful effects following the administration of hypertonic salt or sugar solutions were observed in any of the above-mentioned experiments.

The success of this method in the treatment of various pathological conditions, suggested the use of the physical act of osmosis in the treatment of acute free peritonitis.

The fundamental facts concerning the osmotic processes in the abdomen are summarized in Hamburger's book " Osmotic Pressure and Ions." [30] He demonstrated that the osmosis takes place also through a serous membrane which has been badly injured, for instance, by hydrochloric acid, heat and so on, or even in dead animals; the transudation is chiefly a physical process.

We are indebted to Wegner [31] for the exhaustive study of the capability of the peritoneum to secrete. He calculated that the peritoneum in a woman of medium size has an area of 17,182 square cm., almost equal to the total surface of the body of the same person, which was 17,502 square cm. Wegner injected into the abdomen liquids of a high diosmotic equivalent such as

concentrated sugar solution and found that in one hour an amount of liquid equal to 4 to 8 per cent. of the weight of the animal was secreted.

Kuhn [32] repeated the same experiments and recommended the use of hypertonic sugar solutions in peritonitis. Rogge,[26] following the suggestion of Rindfleish, used hypertonic salt solution in several cases of peritonitis.

After this short review of literature, we may proceed to an account of our own experiments and their results. We studied systematically the efficiency of intra-abdominal injections of hypertonic sugar solution in peritonitis. For this purpose we used ninety rabbits, approximately of the same size and weight.

We found that a normal rabbit can stand safely an injection of one-fiftieth of its weight in 20 per cent. glucose. After injection of a larger amount of glucose, some of the animals died with cramps because of a rapid dehydration of the blood.

In order to determine the rate of secretion we injected the same amount of glucose into a group of animals and killed them at certain intervals to test accurately the quantity of liquid secreted. The experiments showed these results:

Following injection of 50 c.c. of a 20 per cent. glucose we found in the peritoneal cavity:

After 1 hour, 85 c.c. colorless, clear, partially coagulated liquid; after 2 hours, 70 c.c.; after 2 hours 20 minutes, 90 c.c.; after 2 hours 30 minutes, 140 c.c.; after 3 hours, 110 c.c.; after 3 hours 20 minutes, 140 c.c.; after 3 hours 30 minutes, 97 c.c.; after 4 hours 30 minutes, 120 c.c.; after 5 hours 30 minutes, 90 c.c.; after 7 hours, 100 c.c.; after 7 hours 30 minutes, 150 c.c.; after 24 hours, 0.

By injecting physiologic salt solution hypodermically we were able to increase still further this enormous transudation. For example, in one rabbit we obtained 150 c.c. of liquid two hours after glucose injection, and in another one as much as 200 c.c. seven hours later; this shows an increase of four times the amount injected.

In the second group of animals we produced peritonitis by injecting a culture of staphylococci the virulence of which was intensified to such a degree as to cause death in approximately forty-eight hours. An incision was made in the midline without anæsthesia, the peritoneum exposed, a canula introduced and a purse-string suture placed around it; 5 c.c. of suspension of bacteria simultaneously with a small blood-clot were injected, the canula withdrawn, the suture tied, and the abdominal wall closed by means of continuous sutures. The glucose was injected four to twenty-four hours after introduction of staphylococci. The injections were repeated three to six times, at intervals of six to twelve hours. The results were as follows: All the twenty control animals which received injections of staphylococci only, died within twenty-four to forty-eight hours. Of the animals which after production of peritonitis received glucose injections, only one died after thirty-

six hours. Three died after six, nine or eleven days, respectively. The remaining fourteen survived the experiment, but with exception of one were killed to determine the pathologic changes about three weeks later. In all these animals we found a pronounced free peritonitis chiefly of purulent-fibrinous character; in two cases there were caseous changes. In all the animals it was a free, disseminated peritonitis. The mesenteric blood-vessels and lymph-nodes were enlarged, there were many adhesions between the intestines and a large amount of pus in the abdominal cavity.

These experiments prove conclusively, that it is possible to save the rabbits with peritonitis, by intra-abdominal injections of hypertonic glucose solution and to succeed even if the injections are first given twenty-four hours after the introduction of staphylococci.

A series of experiments proved that the amount of exudate in rabbits with peritonitis is approximately the same as in normal rabbits.

To meet the objection that the sugar has merely a nutritional value and the good results are not due to the osmotic action, we injected in two rabbits the same amount of glucose solution hypodermically. Both animals died within twenty-four hours. Thus a hypodermic injection of sugar was without therapeutic effect. Many blood smears were prepared; neither red nor white blood corpuscles showed any changes after glucose injections.

In two rabbits we produced an aseptic chemical peritonitis by injecting into each of them three c.c. of turpentine oil into the peritoneal cavity. One of these rabbits received afterwards the sugar treatment and survived, the other without treatment died in twenty-six hours.

We noticed that twenty-four hours after glucose injection no free liquid was found in the peritoneal cavity; the exudate must have been reabsorbed. The bacteria and their toxins are distributed through a greater amount of liquid when glucose is injected and they enter the blood stream more slowly, thus giving the organism more opportunity to counteract them. Therefore the animal recovers though the exudate is reabsorbed.

In addition to this the reabsorption causes the sugar to enter the blood-stream. We made many sugar determinations in the blood as well as in the peritoneal exudate, taking every possible precaution against disturbing factors such as narcosis, alimentary glycemia, etc. A specimen of the peritoneal fluid taken two hours after injection of forty c.c. 20 per cent. glucose contained 18.5 per cent. glucose; four hours after the injection we found 13.5 per cent. Corresponding to the diminishing sugar content of the peritoneal liquid we could notice a considerable elevation of the blood sugar level. The blood sugar content before the injection of glucose in one experiment was 0.06 per cent., four hours after the injection, 0.198 per cent., or more than three times the previous amount. In another experiment we found the following figures: Before the injection 0.07 per cent.; two hours after injection 0.147 per cent.; four hours 0.1 per cent.; six hours 0.204 per cent., or again about three times the previous amount; twenty-four hours after

glucose injection the normal sugar level was again reached. Urine analysis showed sugar absent or present in only negligible amounts, which proves that the sugar introduced was burned in the organism or transformed into glycogen and stored in important organs such as liver, heart, muscles, etc. The sugar tolerance was thus not exceeded; the assimilation limit was not reached.

The reasons why we used sugar solution and not any other hypertonic solution for our experiments are as follows:

1. Sugar prevents coagulation of the blood; thus the resorption of the liquid blood which may be found in the peritoneal cavity is made possible and the bacteria are deprived of an excellent culture medium in form of blood-clots. The sugar may also act as a prophylactic by preventing the formation of post-operative thrombosis.

2. Sugar counteracts the acidosis which develops following starvation and dehydration of the body by sparing the combustion of fat and proteins with the resulting formation of toxic acid bodies. When there is a lack of sufficient amount of carbohydrates, the toxic acid bodies are produced; the most obvious procedure therefore is to introduce into the body a carbohydrate as glucose that can most easily be burned.

3. Sugar possesses the power to divert the bacteria from the production of proteolytic enzymes and toxins. Abderhalden [32] (cited by Kuhn) proved that all carbohydrates prevent in a greater or lesser degree the formation of proteases. The production of indol ceases when we add sugar to a culture of coli which contains albumen. Ochsner applies sugar to decomposing carcinomatous ulcers in order to prevent formation of offensive products of decay.

4. Sugar has certain bactericidal power. Reschke [33] noted that when sugar was added to a culture of streptococci, the number of colonies was less than in a similar culture without sugar and the hæmolytic zone was smaller. Neisser[34] found that the dissolving action of staphylococci on albumen is reduced by the addition of sugar. According to Heyrovsky [32] (cited by Kuhn), pneumococci grow abundantly in sugar bouillon, but the cocci show signs of degeneration, bloating, discolor, etc., Pfeiffer,[35] Stern,[36] Panzini,[37] demonstrated that the peritoneal secretion destroys or prevents the multiplication of bacteria which are the usual inhibitions of the intestines, but has little or no influence upon the staphylococci and streptococci.

Kuhn [32] established the fact that the sugar causes many bacteria, for example, Staph. pyog. aur., Bac. pneum., Bact. coli, aerogenes and others, to form acid products. The importance of this consists in the fact that the acid products are generally harmless and the alkaline are injurious and dangerous. Many germs cause fermentation of carbohydrates and production of lactic acid and when the supply of the carbohydrates is exhausted they decompose the peptones and form toxins, ptomaines and other injurious substances. In this way a supply of sugar prevents the production of these substances.

5. Sugar is a food easily assimilated and with a high nutritive value as well as a stimulant to the mechanism of cell metabolism, according to the results of experiments of Lusk.[38] Lennander, Tallerman [39] and many others

applied sugar by rectum and hypodermically to provide nourishment in serious cases. As pointed out, the sugar content of the blood increases as much as three times after intraperitoneal injection of glucose; practically no sugar is eliminated by the kidneys.

6. Due to its heavy, syrup-like consistency the glucose solution is a good mechanic isolator for the intestines, and in this way removes the greatest obstacle to permanent drainage, *i.e.*, the formation of adhesions and matting together of the coils of intestines.

Conclusion.—The most important factor in the treatment of acute free peritonitis is the prophylaxis. However, in spite of the advance of the medical science there will always be cases where peritonitis may develop, for example, post-abortive and puerperal peritonitis; typhoid, dysenteric, tuberculous, syphilitic, carcinomatous ulcers of the bowels, appendicitis, ulcers of stomach and duodenum, strangulated hernia, intussusception, penetrating wounds of the abdomen, etc.

In order to make the treatment of free peritonitis as physiologic as possible, that is to stimulate the natural function of the peritoneum, we experimented successfully in rabbits with intra-abdominal injections of hypertonic glucose (20 per cent.) solution. Since this method is absolutely harmless and gives encouraging results, we feel justified to suggest that this treatment be used in human beings in suitable cases. About 500 c.c. of 20 per cent. glucose solution would be the proper amount to begin with. The injections could be repeated through the drainage tube every six to twelve hours. Certain fundamental principles laid down for the treatment of peritoneal inflammation, notably by Fowler, Murphy, Ochsner and Crile, have to be strictly observed, namely, gastric lavages, Fowler's posture, permitting absolutely nothing to be put into the stomach, recta! feeding, introduction of liquids into the system by proctoclysis, hypodermoclysis or intravenous infusions, avoidance of purgation, etc. In addition to this at the end of the operation if such one is indicated we may pour the glucose solution into the abdominal cavity and repeat the injection through the drainage tube periodically.

LITERATURE

[1] Murphy: Transact. Amer. Surg. Assoc., vol. xxvi, p. 46, 1908.
[2] Lennander: Deutsche Zeitschr. f. Chir., vol. lxxxi, p. 1, 1906.
[3] Clairmont and Haberer: Arch. f. klin. Chir., vol. lxxvi, p. 1, 1905.
[4] Glimm: Deutsche Zeitschr. f. Chir., vol. lxxxiii, p. 254, 1906.
[5] Pfannenstiehl and Hoehne: Münch. med. Woch., vol. xlix, p. 2508, 1909. Arch. für Gyn., vol. lxiii, p. 563, 1911.
[6] Hirschel: Brun's Beitr. 3 Klin. Chir., vol. lvi, p. 263, 1907.
[7] Krecke: Monatsschr. f. Geb. u. Gyn., 1911, April.
[8] Schnitzler and Ewald: Wien. klin. Rundschau, vol. ix, p. 273, 1895. Deutsche Zeitschr. f. Chir., vol. xli, p. 341, 1895.
[9] Exner: Zeitschr. f. Heilk., vol. xxiv, p. 302, 1903. Arch. f. exp. Path., vol. l, 1903.
[10] Van der Velden: Deutsche med. Woch., vol. xxxv, p. 197, 1909.
[11] Weed and McKibben: Amer. Journ. of Physiol., vol. xlviii, p. 513, 1919.
[12] Cushing and Foley: Proc. Soc. Exper. Biol. & Med., vol. xvii, p. 217, 1920.

[13] Sachs and Belcher: Journ. of the Amer. Med. Assoc., vol. lxxv, p. 667, 1920.
[14] Sansum: Journ. of the Amer. Med. Assoc., vol. lxviii, No. 25, p. 1885, 1917. Arch. of Intern. Med., vol. xix, No. 2, p. 311, 1917.
[15] Wells and Blankinship: Journ. of the Amer. Med. Assoc., vol. lxxiv, No. 2, p. 75, 1920.
[16] Lichtfield: Journ. of the Amer. Med. Assoc., vol. lxiii, No. 4, p. 307, 1914, and vol. lxxi, p. 503, 1918.
[17] Erlanger and Woodyatt: Journ. of the Amer. Med. Assoc., vol. lxix, No. 17, p. 1410, 1917.
[18] Von Noorden and Salomon: Handb. d. Ernähr. Lehre, Berlin. Springer, p. 1077, 1920.
[19] Singer: Wien. kl. W., vol. xxxiv, No. 8, p. 86, 1921. Münch. med. W., No. 6, 1915.
[20] Gärtner and Beck: Cit. by Singer.
[21] Stejskal: Wien. klin. Woch., vol. xxxiv, No. 17, p. 200, 1921. No. 28, 1921.
[22] Lo Monaco: Congrès de Physiol., 120, Paris Résumés.
[23] Medeviélle: Journal de médecine de Paris, Avril 7, 1920, p. 133.
[24] Singer: Ther. Monatshefte, 1914, Maiheft.
[25] Wright and Moynihan: Cit. by Crile, Surg., Gyn. and Ob., vol. xx, No. 6, p. 708, 1918.
[26] Rogge: Beitr. z. kl. Ch., vol. cvi, p. 167.
[27] Stiede: Münch. med. Woch., No. 3, 1918. Deutsche med. Woch., No. 32, p. 882, 1918.
[28] Strauss: Deutsche med. Woch., No. 52, p. 1719, 1912.
[29] Buerger and Hageman: Deutsche med. Woch., No. 8, p. 207, 1921.
[30] Hamburger: "Osmotischer Druck und Ionenlehre."
[31] Wegner: Arch. f. kl. Chir., vol. xx, p. 51, 1877.
[32] Kuhn: Arch. f. kl. Chir., vol. xcvi, B. 3, p. 759, 1911.
[33] Reschke: Arch. f. kl. Chir., vol. cxvi, p. 466, 1921.
[34] Neisser and Lipstein: Handb. d. Bacteriol. v. Kolle und Wassermann, vol. iii, p. 119.
[35] Pfeiffer: Zeitschr. f. Hyg., vol. xvi, pp. 18, 20.
[36] Stern: Zeitschrift f. klin. Med., vol. xviii, 1891.
[37] Panzini: Ziegler's Beitr., vol. xii, 1893.
[38] Lusk: The Science of Nutrition. Ed. 3, Philadelphia.
[39] Tallerman: Quart. Journ. of Med., July, 1920. Brit. Med. Journ., vol. ii, p. 60, 1920.

THE INFLUENCE OF HEMORRHAGE ON THE MORTALITY IN GUNSHOT WOUNDS AND OTHER INJURIES OF THE ABDOMEN — WITH AN ANALYSIS OF 69 CASES

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This paper is based on a study of 69 cases of abdominal wounds which have been treated in St. Vincent's Hospital, the Hillman Hospital and the Employees Hospital of the Tennessee Coal, Iron and Railroad Company, during 1921 and 1922, with a few cases late in 1920. Eighteen cases have been treated in my own service; 27 cases are from Dr. Lloyd Noland's clinic of the T. C. I. Hospital; and the remaining 24 cases have been in the services of Doctors Ledbetter, Drennen, Davis, E. P. Hogan, G. A. Hogan, C. H. Moore, H. L. Jackson and Wilder, my associates on the staff of the Hillman and St. Vincent's Hospitals, all of whom I thank for the privilege of making use of case records.

With the exception of three farmers and one railway shopman, the patients have been unskilled laborers or members of their families.

There were 6 white patients and 53 colored.

Altercations, assassinations, or conflicts with officers of the law accounted for 52 cases, while one suicidal wound is noted, and 6 were attributed to accident.

The patients, as a whole, are of the most vigorous class of individuals, the greatest number being between the ages of twenty and forty, while there were four children under twelve years of age, and one man of sixty-three.

The cases were handled expeditiously; all but four reaching the hospital within a few hours of the time of the injury and undergoing operation without further delay than that necessary for examination, diagnosis, and surgical preparation. As far as the records show, all operative cases except seven underwent operation within eight hours after injury.

With these points in mind I feel that we are dealing with a series of abdominal injuries on healthy patients, who should be the best possible surgical risks, and who have been expeditiously treated, in well-organized hospitals, by skilled and competent surgeons, according to the best present-day surgical teaching.

While the series is not large, the statistics give a fair indication of what is being accomplished with this class of patients in civil life.

An analysis of the injuries sustained and the results obtained shows that the high mortality is not due to perforation or laceration of abdominal viscera, since all types of injuries were successfully treated by operation, but that it is due to the massive hemorrhage which is often associated with visceral injury.

By early repair of the damaged viscera we save the patient from peritonitis, but, as the records show, we do not, with our present methods of treatment, compensate for the loss of blood which has taken place in certain cases.

TABLE No. I

Classification According to Cause.

Crushing injury—rupture of spleen	1
Stab wounds	9
Gunshot wounds	59
Total	69
Deaths	41
Mortality	59.4

As stab and gunshot wounds present the same general type of injury, no attempt is made to provide separate statistical tables. Ordinarily, the stab wound is a less serious injury than the gunshot wound by reason of the more limited range of the knife as compared with the bullet.

The one crushing injury in the series is included in the "large hemorrhage" group and will be discussed somewhat in detail further on.

For purposes of closer study, the cases are further subdivided as follows:

TABLE No. II

SUBDIVISION INTO GROUPS

Group No. 1

Large Hemorrhage Series

		Cases	Deaths	Mortality
"A" Cases not operated on by reason of collapse from hemorrhage when admitted:				
Gunshot wounds	9			
Stab wounds	1	10	10	100 %
"B" Operative cases. Large hemorrhage, with extensive visceral injury:				
Gunshot wounds	24			
Stab wounds	2			
Crushing injury	1	27	24	88.8%
Total		37	34	91.8%

Group No. 2

Small Hemorrhage Series

		Cases	Deaths	Mortality
"A" Operative cases. No material hemorrhage, extensive visceral injury:				
Gunshot wounds	17			
Stab wounds	2	19	6	31.5%
"B" Explorations: Wounds non-penetrating (5), or penetrating with no visceral perforation (8)				
Stab wounds	9			
Gunshot wounds	4	13	1	0.76%
Total		32	7	21.8%

Looking into these groupings, we find in No. 2, Group "B," 13 explorations with no visceral perforation and only one death. This death was in one of my own cases, and resulted from pneumonia from injury to the right thorax, and should not be charged to the abdominal injury. The low mortality shows the comparative safety of such explorations.

In Group No. 1 "A" we find 10 fatal cases in such collapse on admission that no operation could be undertaken. This demonstrates the desperate state which is quickly reached when large vessels are injured.

A comparison of the operative cases in Groups Nos. 1 and 2 gives interesting and startling information.

The patients in both these groups received the same class of visceral injuries, as is shown in Table III. They were treated in the same hospitals, with the same expeditiousness, by the same surgeons, and under identical surroundings.

TABLE No. III

Visceral Injuries Sustained in Operative Cases

	Large Hemorrhage Series	Small Hemorrhage Series
Cases	27	19
Deaths	24	6
Mortality	88.8%	31.5%
Perforation or laceration of		
Bladder	2	3
Small intestine	14	10
Large intestine	7	5
Liver	7	3
Kidney	1	2
Stomach	7	3
Spleen	2	0
Mesentery	11	1
Simultaneous injury to other important structures:		
Spinal cord	1	0
Lungs and pleura	2	2

In one group we find a mortality of 31.5 per cent. and in the other a mortality of 88.8 per cent.

The great difference in the two groups is that on the one hand the injuries are unassociated with any material loss of blood, while on the other we have the addition of massive hemorrhage.

Injuries of the abdominal viscera will always have a certain unfavorable mortality from peritonitis, obstruction, and other postoperative complications, but a consideration of the case here presented shows that the extremely high mortality encountered is the direct result of hemorrhage, all the fatal cases in Group No. 1, except 8, dying within a very few hours, before sufficient time had elapsed for the development of fatal inflammatory or mechanical complications. The deaths, also, which took place later, were no doubt influenced by the lowered resistance from loss of blood.

All patients received the usual treatment for shock, namely, heat, opium, proctoclysis, hypodermoclysis, intravenous salines, and various cardiac stimulants. That these remedies are entirely ineffectual in overcoming the effect of large hemorrhage is demonstrated by the mortality of 88.8 per cent.

The brilliant results obtained by transfusion in all types of acute hemorrhage teach us that, if we are to lower this high mortality rate, donors must be obtained and transfusion must be practiced.

In only three cases of this series was transfusion resorted to, and one life was saved thereby.

The problem with this class of patients is the difficulty in securing donors. Patients are often friendless or out of touch with friends and family; such friends or acquaintances as sometimes accompany them are often ignorant, suspicious or afraid, and flatly refuse or disappear upon the suggestion that they act as donors. The patients and their friends are seldom able to pay donors for transfusion.

In the Hillman Hospital, which receives free patients from the city and county, in many years' service on the surgical staff, I have only been able to obtain two donors for immediate transfusion, though, on several occasions, when the emergency has not been so pressing, we have obtained suitable donors after some delay.

Every hospital that sets out to care for these injuries must be prepared to carry out, without delay, all the laboratory and operative detail of blood transfusion.

This demands that the laboratory staff be ready for blood matching at all times, and involves the typing of the blood of a large number of hospital employees who might consent to act as donors under certain circumstances.

The operating room service and the surgical staff should be so organized that patients may be transfused with no further delay than that necessary for procuring suitable donors.

This plan is in use in many hospitals that care for patients of better social and financial status, and while it will be difficult to put in operation with the cases under consideration, it should, nevertheless, be persistently attempted.

Transfusion should be considered as much a part of the treatment of these cases as the laparotomy, and when the surgeon and his staff consider the problem from this standpoint, an increasing number of donors will be obtained.

Auto-transfusion.—Auto-transfusion or auto-reinfusion of blood is a therapeutic measure of promise in a limited number of cases. This practice, introduced by Thies in 1914, and used first by Lichtenstein, in hemorrhage from ruptured ectopic pregnancy, was used in a small number of cases of traumatic hemorrhage in the recent war, and in a few cases from civil life.

Fieber,[1] Peiser[2] and Ranft[3] report successful auto-reinfusions in ruptured spleen; two cases resulting from gunshot wounds, and one from the kick of a horse.

Elmendorf [4] reports a successful auto-reinfusion of 300 c.c. of blood drawn from the pleura following gunshot wound of right thorax.

Kreuter [5, 6] reports one successful auto-reinfusion in rupture of the liver caused by the kick of a horse, also one unsuccessful case in gunshot wound of the liver.

In the unsuccessful case he states: "The blood infusion was performed by an assistant during the operation. The patient was dying. The effect of the auto-infusion was marvelous. He recovered consciousness, but improvement lasted only a few hours. Autopsy showed that the patient died from progressive hemorrhage from an untreated wound of the kidney.

In hemorrhage from liver or spleen, and from mesenteric or other vessels, unassociated with contamination from injury to intestinal or urinary tract, auto-reinfusion is indicated and can be very easily carried out.

In this series there were three deaths from injury to the liver where it could have been employed. In one rupture of the spleen it could also have been used if a donor had not been at hand.

The brilliant results obtained in the small series of traumatic cases above referred to and in the more extensive experience of gynecologists, indicate that it is a therapeutic agent of great value in selected cases.

In our series only three transfusions were performed, one in Doctor Noland's clinic and two in my own service at the Hillman Hospital.

In Doctor Noland's case the patient was moribund following an operation for gunshot wound of abdomen involving the liver. He did not survive.

In one of my cases, a gunshot wound of the liver and right lung, patient died while transfusion was in progress, with symptoms of anaphylaxis, though the blood had been carefully matched in the laboratory.

My second case, rupture of the spleen, resulting from a wagon passing over the body of the patient, recovered.

I feel that the recovery of the patient was due directly to the transfusion. The case presents so many interesting points it will be briefly reported.

> At 8 A.M., July 8, 1922, the patient, a white boy of fifteen, was run over by a wagon loaded with lumber. He was brought about 25 miles to the Hillman Hospital where I saw him at 8:10 P.M. His temperature was 99-4/5; pulse 84; blood pressure S. 115, D. 80; extensive abrasions were present over entire back, most marked over left lower ribs. There was no evidence of fractured ribs or of spinal injury.
>
> His abdomen was rather rigid, and there was generalized soreness but no point of special tenderness. There was some suggestion of fluid in left flank. The urine was free from blood. He was suffering some pain across the upper abdomen and in his chest, but was not shocked.
>
> His symptoms were so indefinite that we decided on further observation. The next morning he was again examined, Dr. E. P. Hogan being in consultation with me.
>
> We found temperature 96-2/5; blood pressure S. 66, D. 42; pulse of 120. His abdomen was slightly distended, and signs of fluid were definitely present in the peritoneal cavity. He was pale and sweating, and complained of a feeling of great weakness.

A diagnosis of abdominal hemorrhage was made, from rupture either of liver or spleen. It was evident that he would not survive an operation in the condition he then presented. His father was found to be a suitable donor, so we decided on a transfusion, to be followed by operation under local anæsthesia.

Five hundred c.c. of citrated blood, together with 200 c.c. of normal salt solution, were given, and the blood pressure rose from S. 66, D. 42 to S. 80, D. 55 with a corresponding improvement in his strength.

Under .5 per cent. novocain the abdomen was opened through a right rectus incision. The liver was found intact. A large intra-peritoneal hemorrhage was present, and the spleen was found to be badly lacerated. As removal of the spleen was impracticable through the right rectus incision, the line of anæsthesia was carried across the abdomen to the left; a transverse incision was made and the spleen was easily exposed.

Splenectomy was performed, and the abdomen was closed with a cigarette drain.

The operation was carried out under local anæsthesia and the only pain complained of was that which attended the lifting of the spleen from its bed when the pedicle was clamped and ligated.

He made an uneventful recovery.

The other spleen case of the series, a gunshot wound involving spleen, stomach and right pleura, is in striking contrast to this one. He died on the operating table from the effects of hemorrhage, to overcome which no donor was available.

SUMMARY AND CONCLUSIONS

1. The mortality of 88.8 per cent. in the "Large Hemorrhage Series," as compared with 31.5 per cent. in the "Small Hemorrhage Series" teaches that our treatment of hemorrhage must be improved.

2. Transfusion must be more extensively employed.

3. Auto-reinfusion should be practised in selected cases.

4. If cases are seen early, and observation indicates that hemorrhage is not progressive, operation may well be deferred a short time, while waiting for reaction, and while efforts are being made to obtain donors for transfusion.

REFERENCES

[1] Fieber, E. L.: Auto-reinfusion in Rupture of the Spleen. Zentralbl. f. Chir., Leipz., 1918, vol. xlv, i, pp. 413–416.

[2] Peiser: Auto-reinfusion of Blood in Rupture of the Spleen. Zentralbl. f. Chir., Leipz., 1917, vol. xliv, i, pp. 71–74.

[3] Ranft, Gustav: Auto-transfusion Following Rupture of the Spleen. Zentralbl. f. Chir., Leipz., 1917, vol. xliv, ii, p. 1019.

[4] Elmendorf: Reinfusion after Puncture of a Fresh Hæmothorax. Munchen. med. Wchnschr., 1917, vol. lxiv, i, p. 36.

[5, 6] Kreuter: A further case of Reinfusion of the Blood in Intra-abdominal Hemorrhage in Rupture of the Liver. Zentralbl. f. Chir., Leipz., 1917, vol. xliv, ii, p. 765. Reinfusion in Abdominal Hemorrhage. Minchen. med. Wchnschr., 1916, vol. lxiii, p. 1498.

END-RESULTS IN MALIGNANT DISEASE OF THE TESTIS*

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In a previous article, sixty-four cases of malignant disease of the testis were reported. Since then, there have come under observation fourteen other cases, making a total of seventy-eight. In this entire series, the great majority of cases were observed in the later stage of the disease, after recurrence had taken place, and the condition had become practically hopeless as regards a permanent cure. Only fifteen of the cases were seen during an operable stage, before there was any evidence of metastasis. Of these, the toxins were used as a prophylactic after operation in ten cases. Five were treated by operation without prophylactic after-treatment of any kind: one of these was an embryonal carcinoma which has remained well four years after operation; one died of metastases within a year of castration; and the other three cases have not been traced.

In the ten cases in which the toxins were used, alone in nine cases and combined with radium in one case after operation in the hope of preventing a recurrence, nine are living from three to fourteen years after operation; four are alive ten to fourteen years later. One of these cases, after remaining well for fourteen years, had a recurrence in the other testicle, which was removed by operation, and the diagnosis confirmed by microscopical examination (Table I). In addition to these cases, there are three others which were treated after a recurrence had taken place but before abdominal metastases had occurred, which recovered under the toxins alone, and the patients have remained well from five to twelve years (Table II).

Barringer [1] reported thirty-five cases of sarcoma of the testicle, nearly all of which had been treated with radium alone, and a few cases, with radium and X-ray. Of this series there was only one patient well over three years: a large, recurrent metastatic tumor of the abdomen, which entirely disappeared under treatment; and the patient was well at the time of last observation, three years and five months later. His report includes only three cases in which radium was used as a prophylactic measure after castration of a primary operable tumor of the testis; and of these cases, one remained well for nine months, one died, and one was not traced.

In a larger number of cases, abdominal recurrence had taken place which, under radium treatment alone, and in some cases under X-ray alone, showed marked regression. Barringer reported one case of remarkable regression; a large inoperable mass filling the right pelvis, which disappeared under a single radium pack application, and the patient remained well for three years and five months. In one case on my own service, a tumor the size of a man's

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head, practically entirely disappeared in the short period of two weeks under a single massive dose of radium; but about two months later, the tumor recurred and again nearly disappeared under radium; however, each succeeding treatment had less and less effect; and the patient died within six months from the time of the first treatment. These cases emphasize the fact that, in order to obtain a permanent cure in malignant disease of the testis, a proper form of treatment should be given at the time of the primary operation, before visible or palpable metastases have occurred; as there is little hope of obtaining a permanent cure after such metastases have developed.

Sarcoma of the testis occurs usually during the prime of life; and trauma has been noted as a probable causative factor in thirty-three and one-third per cent. of our cases.

Age: 1 case —20 months,
2 cases between 15–20 years,
20 cases between 20–30 years,
32 cases between 30–40 years,
12 cases between 40–50 years,
3 cases between 50–60 years.

Total, 70 cases.

The question of the pathology of malignant tumors of the testis has been exhaustively discussed by Ewing [2]; who in a careful microscopical study of nineteen cases of tumors of the testis, reached the conclusion that all such tumors had their origin in teratomas. Although there has been a gradual trend on the part of pathologists to accept in part the views of Ewing as regards the pathology of the majority of testicular tumors, few are willing to believe that all such tumors are of teratomatous origin. Chevassu, in his study of one hundred cases, classified only one as a teratoma, forty-seven as epithelioma seminal, fifty as mixed tumors, and the others as sarcomata.

One of the most important papers on the subject, published since 1911, is that of Schultz and Eisendrath,[3] based on a review of the pathological diagnosis of microscopic sections of fourteen malignant tumors. They state that it is evident that there are still wide differences of opinion as to the origin and nature of tumors of the testicle; and that any histogenetic classification which attempts to include these diverse views must remain as complicated and unsatisfactory as most of the text-book classifications are to-day. Among the conclusions reached by these two authors are the following:

"For these tumors whose teratomatous origin is either definitely established by the presence of heterologous elements or is rendered very probable by the character of the atypical tissue, the designation embryonal carcinoma should be accepted. This term may be modified by the adjective hypoblastic, trophoblastic or epiblastic if the atypical tissue is glandular, syncytial or solid. Quite distinct from the embryonal carcinomas are the tumors of the solid, medullary, large cell type. The distinguishing characteristic of these tumors is the cell type. The tumor cell is morphologically identical with the younger

TABLE I.

Table of Cases of Malignant Tumors of Testis Observed in Operable Stage. End Results after Operation Followed by Prophylactic Toxins.

No.	Name	Age	Date	Duration	Pathologic diagnosis	Trauma	Post-operative treatment	End result
1	P. G.....	51	June, 1907, operation, Dec., 1908	6 months size of closed fist	Round-celled sarcoma by Doctors Mandelbaum, Welch, and Ewing	No	Toxins of erysipelas given immediately after operation, for 3-4 months by Dr. Lilienthal	Patient well March, 1923, 14 years
2	R. M. M.....	32	Operation, Oct. 7, 1912 by Dr. C. C. Kimball	3 months	Large round-celled sarcoma (Fig. 3).	No	Toxins begun soon after operation and continued for several months	Patient well March, 1923, 11 years
3	T. H. M.....	28	Operation, Dec. 2, 1910, Mayo Clinic	4 months	Sarcoma	Yes Tumor 4 weeks later	Toxins began soon after operation and kept up nearly a year. Temperature reactions — 104°, highest dose — 42 minims	Patient well 8 years later. Died of influenza, Nov. 21, 1918
4	D. E. B.....	37	Operation, June, 1908 by Dr. John B. Murphy	Few mos. rapid growth	Round-celled sarcoma undescended testis, diagnosis confirmed by Dr. Ewing	No	Toxins begun as soon as wound healed and kept up with intervals of rest for six months	Well for 3 years, then developed metastasis in abdomen. Died at the end of 3 years and 9 months.
5	D. R.....	44	Removal of right testis by Dr. J. A. Wyeth, 1899 1 year later recurrence in left testis	Few months	Round-celled right testis. Patient refused to have left testis removed	No	Toxin treatment for 6 months carried out under Dr. Coley's direction	Patient personally examined 8 years later and well 15 years later when last heard from.
6	J. P.....	Adult	Removal Nov., 1910, Mayo Clinic	Few months	Sarcoma	?	Toxins begun soon after operation. Kept up 1 year	Well 7 years.

7	T.....	46	Feb. 23, 1906	3 months	Round-celled sarcoma	No	Toxins 1 month after operation. Recurrence in glands, inguinal and iliac, had taken place	Well 8 years later.
8	G. J.....	37	Dec. 10, 1910 (Coley), size of orange	7 months	Teratoma typical, Dr. Ewing	No	Toxins after operation	Well 3 years later.
9	W. M. H.....	26	Operation, Feb. 1, 1906	3 months	Round-celled sarcoma	Yes soon after	Toxins begun 1 month after operation and continued for several months	Well Dec. 22, 1922, 17 years later.
10	L. G.....	24	Operation, Nov. 2, 1917	3 months	Large round-celled sarcoma. Report by M. Schofield, Pathologist to Royal Free Hospital, London, confirmed by Dr. Ewing (embryonal carcinoma)	Yes 4 months before	Toxins Feb. 3, 1918, 1 dose radium-pack given March 18, 2nd pack Sept. 18, toxins kept up nearly 1 year	Patient well Feb., 1923, 5 years.
11	R. H.....	20 months	1st operation, April, 1917, 2nd operation, June, 1917, 3rd operation by Dr. Coley, Oct. 19, 1917	3 weeks	Sarcoma of testis, Dr. Ewing. (One of few cases Dr. Ewing has seen which he believes is a true sarcoma of testis)	Yes few months before	Toxins begun immediately after third operation (removal of very large, fungating tumor) toxins kept up 2½ years with intervals of rest	Patient in good health, March, 1923, 5½ years.
12	S. S. S.....	42	1st operation, 1902. Inoperable recurrence abdominal metastases, June, 1919	Recurred 1919, retroperitoneal tumor and large metastases in left supraclavicular pleura	Large round-celled sarcoma. Prof. of Pathology, Harvard Medical School	No	X-ray at Mayo Clinic, May, 1919, temporary relief. Tumor increased in size. Toxins begun July, 1919. Radium August, 1919. Treatment kept up 3 years	Patient well and free from all evidence of tumor, March, 1923, 3 years and 8 months.

TABLE I. *Continued*

Table of Cases of Malignant Tumors of Testis Observed in Operable Stage. End Results after Operation Followed by Prophylatic Toxins.

No.	Name	Age	Date	Duration	Pathologic diagnosis	Trauma	Post-operative treatment	End results
13	J. D.....	32	Operation, Dec., 1908 (Coley)	?	Carcinoma (Ewing)	No ? Possible trauma from truss	No toxins. Only case in entire series well 4 years after operation alive	Well 4 years later.
14	E. L. F.....	42	Operation, Nov. 22, 1907, Dr. C. A. Porter, Boston	3 months	Round-celled sarcoma	No	Toxins begun 3 weeks after operation given by Dr. Faulkner under Dr. Coley's direction	Patient well 14 years. Then had recurrence in other testis, removed, diagnosis confirmed by mic. ex.
15			Recurrence in iliac and abdominal glands	Inoperable recurrence	Round-celled sarcoma		Toxins, apparent complete disappearance of tumor	Well 3 years, then died of recurrence.
16	?	43	1st operation 1910, 2nd incomplete operation in August, 1910, by Dr. Percy Shields	Inoperable recurrence	Round-celled sarcoma	No	Toxins after second operation, glands disappeared, treatment continued for 1 year	Well 10 years later.

Note:—In three cases the condition was inoperable metastatic recurrence and in two others the toxins were used after 2nd or 3rd operation for recurrence.

TABLE II.

Inoperable Cases Treated with Toxins by other Surgeons.

Name	Age	Date	Duration	Pathologic diagnosis	Trauma	Post-op. T.	End results
Case of Dr. Robbins. Reference, Hinman, Jour. A. M. A. Dec. 5, 1914	55	1st operation, Jan., 1909, 2nd operation, 15 days later, recurrence		Sarcoma	?	Toxins	Disappearance of tumor. Patient remained well for 4 years and then died of nephritis. No evidence of old trouble.
Case of Dr. William Mabon, Manhattan State Hospital, personal communication		Testis removed in 1890, recurrence in tongue five years later		Testis, sarcoma, tongue, round-celled sarcoma, Dr. William H. Welch		Toxins	Well 15 years later.
Case of Dr. Hertel of Copenhagen, reference, Hospitalstidents, April 7, 1909	29	3 recurrences, 3rd operation was Lennander's operation (incomplete)		Sarcoma		Toxins	Glands disappeared. Patient well 10 years.

cells of the spermatogenic cycle and is probably derived from the cells of the seminiferous tubules. For this kind of tumor the term spermatocytoma is suggested."

One has but to note the pathological reports on malignant tumors of the testis made at the various laboratories, and the various reports published in the literature, to become impressed with the great confusion that still exists in the classification of these tumors. For example, Bulkley [4] in his report on fifty-nine collected cases of tumor of the undescended testicle, gives the diagnosis as sarcoma in one form or other in forty cases; the remainder being: teratoma, two; epithelioma, two; chorio-epithelioma, two; carcinoma, seven; rhabdomyoma, one; and cancer, five. Sakaguchi,[5] in studying thirty-two cases of malignant tumor of the testicle, groups his cases as follows: sarcoma, one; typical large cell tumors, twenty-one; atypical large cell tumors, two; epithelial tumors, seven; and one tumor with adenomatous areas and also solid cell nests. Tanner [6] classifies the malignant tumors of the testicle into two main groups, as follows: "1. Carcinomatous; large cell, large nucleus type, undoubtedly closely related to 2. Mixed tumor type: (*a*) Tumors containing cartilage, cysts, glands, etc.; (*b*) ordinary glandular structure tumors; (*c*) chorio-epithelioma."

In the present state of uncertainty as regards classification, we believe it is wise to group all cases of malignant disease of the testis under the general heading of cancer of the testis, as is done by Chevassu,[7] subdividing the different varieties as far as our knowledge permits, into: (1) teratoma, to include the mixed type of tumor, containing cartilage, cyst, glands; (2) embryonal carcinoma, to include the pure solid tumor, may or may not be of teratomatous origin, of the large-celled, large nucleus type; (3) the rapidly diminishing group of pure sarcomata.

End-results Following Surgical Treatment.—In a former paper [8] the opinions of various surgeons here and abroad, as to the curability of malignant disease of the testis by operation, were referred to at some length. Most of the authorities were uniformly pessimistic. There are no statistics, apparently, on which to base an opinion as to the end results following the combined operation of removal of the testis and the retroperitoneal glands by abdominal operation, except those of Hinman [9] and Chevassu. The mortality of eleven per cent. in forty-four collected cases, is sufficient to make one hesitate to adopt this operation until better end results have been obtained. Forty-one per cent. of these cases died at the end of one year. Hinman's statistics represent, probably, the most accurate estimate of the best end results that can be expected of modern surgery alone. Of twenty-four cases traced, of his series of thirty-two, twenty had died and four were living. As regards the pathology of eighteen cases in which the specimens were carefully examined, nine were pronounced pure round-celled sarcoma, and nine teratoma. Of the nine round-celled sarcomas, two are living, one twelve and the other thirteen years; of the latter group (teratoma) only one patient is living, sixteen months. Of seven patients treated elsewhere, only one was living

twelve years later. It is interesting to note that of all the patients who died, none lived for a period of two years; in other words, only three of this group lived longer than three years (about ten per cent. of the total number).

He brought out the very important point that although in only two per cent. of the forty-four cases were the glands palpable at the time of the operation, yet the abdominal operation revealed the fact that in fifty per cent. of the cases, the retroperitoneal glands were involved with the tumor. This would explain why the simple orchidectomy in the past has cured so few cases. Another important fact brought out by Hinman is, that of eight cases in which no glands could be found at the time of the abdominal operation, three later died of cancer. Of the forty-four cases collected, twenty were living at the time of his report, nine over two years, an average duration of one year and eight months. The longest period of freedom from recurrence after operation was four years and ten months in one case.

While sufficient time has not elapsed to determine the number of permanent cures following radical operation, Hinman's statistics show beyond question, that the prognosis can be materially improved by the abdominal operation; but this can only be obtained at the expense of a mortality of eleven per cent. against a mortality of nil following the simple orchidectomy operation. In a second article including five additional cases, Hinman[9] concludes that:

"1. The radical operation for teratoma testis is justified in suitable cases by the high mortality following simple castration; by the definite experimental and surgical demarcation of the primary lymph zone, and by the possibility of the clean and complete removal of this zone.

"2. The radical operation is neither technically difficult, dangerous nor mutilating, as is proven by the fact that it has been successfully performed and the primary lymph zone completely removed in five cases of teratoma testis without a single troublesome operative or post-operative complication.

"3. These five surgical successes indicate that the mortality from this seemingly extensive operation should be little if any greater than that following castration. All five cases enjoy perfect health now nine months, seven and one-half months, four months, three months, two months, and three years and six months, respectively, since operation.

"4. The ultimate result in these five cases cannot be known for years. But the finding in four cases of metastatic tumor tissue in the lymph areas radically removed demonstrates the uselessness of simple castration and the necessity of radical surgery. A cure in any one of the four certainly, and possibly of the fifth, will have been directly due to the early and clean removal of the gland-bearing area."

Tanner[10] basing his report on a study and analysis of one hundred and one cases classifies the tumors in ninety-seven of the cases as malignant, four as benign, thirty-five as mixed or embryoid, and sixty-two as of the soft, cellular, medullary type. He states: "Out of six hundred cases collected which were operated upon, four hundred and sixty-five were followed. Of

these, three hundred and seventy-seven, or eighty-one per cent., were dead; while only twenty-five, or five and one-half per cent., were found to be living and well four years or more after operation." Of Tanner's series of twenty-two mixed tumors, only two were alive over three years; and of the ten tumors found to contain cartilage, all but one case died. Of the sixty-two cases of carcinomatous type, fifty-four were traced, of which twenty-five had died and thirty-one were living, fifteen beyond four years or more after operation, and three over ten years after operation. The statement in reference to my earlier paper [8] that, in fifty-two cases of my own series, the toxins were used after castration as a prophylactic, is a serious error. That study was based upon a series of sixty-four cases, a complete tabulation of which was made at the end of the paper. He assumed that the toxins were used as a routine measure in all of these cases when, as a matter of fact, they were used in only nine cases as a prophylactic and this was so stated.

In his series there were only six cases in whom the toxins were used as a prophylactic after operation; four of these have died, and two are living from seven to nine years after the operation. He adds that, "these two were both of the so-called carcinomatous type of tumor, and about thirty-three per cent. of them are cured by simple castration alone." This is hardly supported by Tanner's own statistics, *i.e.*, of sixty-two cases of the carcinomatous type, thirty-one were living at the time of the report, only seven of which had remained well upwards of seven years, which would make the percentage eleven instead of thirty-three, treated by castration alone. He gives us, however, the first data on which we can base conclusions as to the prophylactic value of radium or X-ray, singly or combined, when given immediately after operation in operable cases. Stating that: "In this series eleven patients received X-ray or radium treatments following castration. X-rays alone were used in seven cases, X-ray and radium in three cases, and radium alone in one case.

RESULTS OF CASES TREATED BY X-RAY

2 living and well 4 years after operation,
1 living and well 3 years after operation,
1 living and well 2½ years after operation,
1 died 3 months after operation,
2 died 7 months after operation.

Total, 7

RESULTS OF CASES TREATED BY X-RAY AND RADIUM

1 living and well 1 year after operation,
1 died 3 months after operation,
1 died 7 months after operation.

Total, 3

RESULTS OF CASES TREATED BY RADIUM

1 living and well 6 months after operation.

From these statistics it is seen that five out of eleven patients are dead, and out of the six who are still alive, only one patient is living over four years. Adding to the above, the three cases which Barringer treated with radium as a prophylactic after operation, one well nine months, one dead, and one not traced, we have fourteen cases, of which only one remained well beyond the period of four years, and two beyond three years. A comparison of these results with those obtained by the use of toxins as a prophylactic after operation, would lead one to the conclusion that the latter agent was of greater prophylactic value.

In view of the fact that such a small proportion of cases have been permanently cured by operation alone, it would seem difficult to explain the freedom from recurrence for such a long period in the present group, on the ground of coincidence. It would seem more fair to conclude that the toxins have an inhibitory action on the growth of the tumor cells, in many cases sufficient to prevent their further development, and in other cases, to postpone their activity for a long period of time. This conclusion is further strengthened by a number of cases in which recurrent tumors, whose malignant nature is unquestioned, have disappeared, and the patients have remained well for a considerable period, finally developing other recurrences which have proven fatal. In these cases, the inhibitory action of the toxins is absolutely demonstrated; but for some unknown reason, it has not remained sufficiently powerful to effect a permanent cure.

If we had no alternative, we might be forced to admit that radical or combined operation should be the method of choice in malignant tumors of the testis; but in our opinion, we have an alternative, which should be seriously considered before resorting to such a serious procedure. Since the publication of Hinman's paper, radium has come into much more general use; and the methods of applying it have been greatly improved. So far we have no large series of cases in which radium has been used immediately after removal of the testis for malignant disease. In such a condition, immediate postoperative radium or X-ray treatment, we believe, will give better results than orchidectomy alone. It was even hoped that by the use of large doses of radium, we might be able to treat successfully the recurrent abdominal cases; but Barringer's experience in nearly fifty cases of recurrent inoperable malignant tumors of the testis which have been treated by radium therapy, has demonstrated otherwise. We have learned that by massive doses of radium, administered in the form of a radium pack, we could, in most cases, produce very marked regression of a large retroperitoneal tumor and in a considerable number of cases, cause its complete disappearance. Yet in practically all of the cases, with one exception, the disappearance or improvement has proven only temporary. Therefore, as far as our present knowledge goes, we must admit that we are unable to offer much hope of a cure if the disease has metastasized in the abdomen sufficiently to produce large and palpable tumors.

The present series of cases show that even better results than those

reported by the combined radical operation advocated by Hinman and Chevassu, can be obtained by simple orchidectomy if the operation is immediately followed by prolonged systemic toxin treatment, with or without radium. We believe that the best results are likely to follow the combined use of massive doses of radium over the abdomen and left supraclavicular glands, and prolonged toxin treatment. Another point worthy of special emphasis is, that these results have been obtained without any mortality.

Method of Toxin Treatment.—This should not be employed at all unless the patient is willing to have it kept up for a considerable period of time, at least six months. It can be carried out at home by the family physician, and need not interfere with the patient's ordinary routine of living. The injection should be made deeply into the buttocks, beginning with a dose of one-half minim, diluted with a little freshly boiled water, and increased daily by one-half minim up to the point of producing a slight reaction, temperature of 99 to 101 or 102 degrees. It should then be given only three times a week, increasing the dose only if necessary, to the point of a moderate reaction. At the end of three months, it is safe to diminish the frequency of the injections to two a week, using doses just large enough to produce slight reactions.

In all cases where it is possible, either radium or deep X-ray therapy should be used in addition, covering the entire retroperitoneal glandular region on the side of the tumor. We believe it wise to repeat these treatments at the end of four to six months. So essential is long-continued treatment, that the introduction of the subsequent history of the appended case (originally reported in full in *Trans. So. Surg. Assoc.*, 1917) will be most germane.

Case I.—R. H., twenty months of age. Trauma a few months prior to appearance of the tumor which was first noticed in May, 1917, in the left testicle. This grew to the size of an orange in three weeks. The testicle was removed at this time by Dr. D. P. Murphy, of Elmira, N. Y. Three weeks later a recurrence took place, of very rapid growth, with involvement of the glands of the groin. A second operation was performed by Doctor Murphy about two months after the first one. This, also, was followed by a rapid recurrence of still more rapid growth. The patient was brought to me on October 19, 1917, and admitted to the Memorial Hospital. Physical examination at that time revealed a very large tumor, the size of two fists, extending down the thigh for a distance of six inches, the lower third of which was a fungating mass with foul smell and discharge. The tumor, which did not extend upward beyond the external ring, was removed, and the wound closed with skin from the other side of the scrotum. The patient was immediately put upon the mixed toxins of erysipelas and bacillus prodigiosus (no other treatment).

Pathological report by Dr. James Ewing (December, 1917): "The specimen is a round, solid, soft, elastic tumor mass, 7 x 8 cm.; it fungates through the skin over an area of 4 cm. wide, a portion of skin accompanying the specimen. On section the tumor is smooth, translucent, hemorrhagic along the fungating edge. It is circumscribed by an indistinct capsule. No portions of the testicle are visible in the single gross section. On microscopic examination the structure is composed of large and small groups of large polyhedral and spindle cells of indifferent embryonal type, consisting chiefly of hyperchromatic nuclei. These cell groups

grade off into an abundant mucinous tissue of myomatous type and every gradation from polyhedral to star-shaped cells may be followed. Some cell clusters surround blood-vessels, which are not numerous. There are scanty small points of necrosis. The diagnosis is embryonal carcinoma of testis, with transition to pseudosarcomatous structure." Doctor Ewing, recently reviewing this case stated, that the diagnosis "embryonal carcinoma," given in his report, was an error, and that he regarded this as one of the very few cases in which he would make a definite diagnosis of sarcoma of the spindle- and round-celled type. (Fig. 1.)

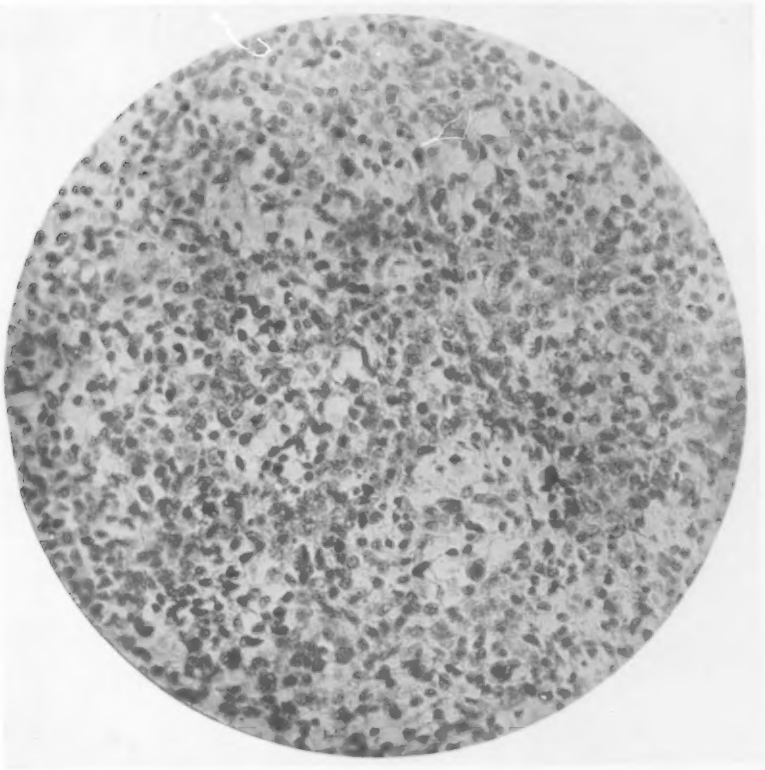

FIG. 1.—Three times recurrent, round and spindle-celled sarcoma of the testes, in a child twenty months old. Toxins given after last operation. Patient in good health over five years later. (Case XI in table.)

The toxins were given for about two weeks and later continued at home by the family physician, to whom it was suggested that the treatment be kept up for a considerable period. At the end of a few months, however, the patient was so well that the treatment was discontinued. About a year and a half later, another nodule the size of a pea, appeared in the neighborhood of the scar. This was removed and pronounced by Doctor Ewing to be of the same structure as the original tumor. The toxins were then resumed and kept up for an even longer period than before. At the present time, five years after the last operation, the patient is in excellent condition with no trace of a recurrence. In this case, in view of the very rapid recurrence after two operations alone, I think it is only fair to assume that the toxins which were given after the third operation played an important part in the final recovery of the patient.

Appended is a detailed report of two recent cases which are of interest.

CASE II. *Recurrent Inoperable Metastatic Sarcoma of Testis, Treated with Toxins and Radium. Well four years.*—S. S. S., forty-two years of age, was operated on for sarcoma of the right testis by Dr. M. J. Seelig, of St. Louis, in 1902. A diagnosis of round-celled sarcoma was made at the University laboratory, and section of the tumor sent to the Professor of Pathology at the Harvard Medical School, who confirmed the diagnosis. The patient remained well until 1918, when he had occasional attacks of cramps in the groin on the right side. It was thought

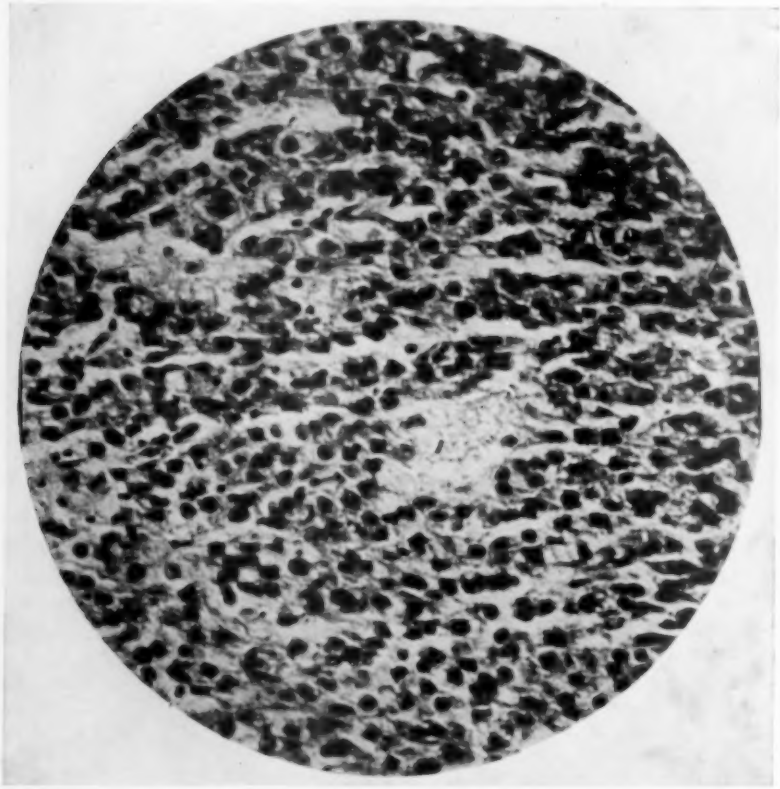

FIG. 2.—Round-celled sarcoma of testes, diagnosed by Doctor Ewing as embryonic carcinoma. Toxins shortly after operation; continued for one year; one radium application over abdomen in March, 1918, and another in September, 1918. Patient well nearly five years. (Case X in table.) (Case III.)

at first that the condition might be due to chronic appendicitis. He went to the Mayo Clinic in May, 1919, and the physical examination report at that time stated: "The large tumor in the abdomen is probably a recurring sarcoma involving the deep glands along the spine. This growth apparently is not attached to any organ. General condition is good." He was put upon X-ray and radium treatment at the Mayo Clinic and under this the tumor subsided considerably. Shortly after returning home, the tumor again began to increase in size, his abdominal symptoms recurred, and another tumor developed in the left supraclavicular region. The patient was referred to me by Dr. Charles H. Mayo in July, 1919, for advice and treatment. Physical examination at this time showed a large tumor in the right lower abdomen, apparently retroperitoneal metastases from the primary tumor of the testicle.

The left supraclavicular region was occupied by a tumor about the size of a hen's egg, apparently another metastatic growth from the primary sarcoma of the testis.† The patient was admitted to the Memorial Hospital and treated with systemic toxins alone. After two weeks' treatment, the mediastinal tumor had diminished to one-third its original size and the tumor in the abdomen had also decreased appreciably. He was then given a massive dose of radium over the left abdomen, and the radium pack was placed on the left supraclavicular tumor. In about three weeks, the supraclavicular tumor had entirely disappeared and the tumor in the

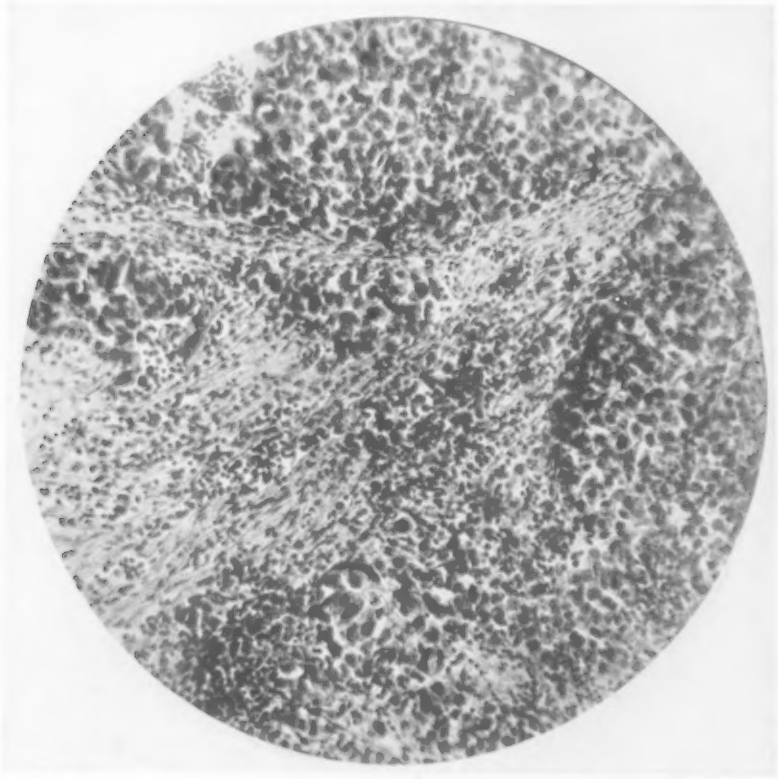

FIG. 3.—Large round-celled sarcoma. Toxins immediately after operation, prolonged treatment. Patient in good health ten years later.

abdomen had steadily decreased in size. The patient returned home where the toxins were kept up for six months, at the end of which time he returned for further radium treatment. Examination failed to reveal any tumor mass in the abdomen or supraclavicular region. Another radium treatment was given over the abdomen, and the toxins were further continued. He has come on for observation every six months, during the first two years, and once during the last year. A careful examination in the fall of 1922 failed to reveal any visible or palpable evidence of any tumor, either in the neck or in the abdomen. After remaining well for three and one-half years, in early January, 1921, he had what was supposed to be an attack of grippe, followed by a pleuritic effusion.

†The author has seen four cases of metastases in the left supraclavicular region following a primary sarcoma of the testis. The explanation is, that the thoracic duct, which drains the abdominal and lymphatic glands, empties into the left subclavian vein.

He has had four aspirations of one-half to three and one-half quarts of chocolate colored sterile fluid. No evidence of metastases of the lungs can be determined by X-ray pictures or fluoroscopic examination. He is well April 1, 1923.‡

CASE III.—L. G., twenty-four years of age, was referred to me by Dr. M. Murray, of Hessle, East Yorks, England, on February 12, 1918. Previous History: The patient served as an officer in the British Army since January, 1915. He was severely wounded in October, 1915, an artery being cut, for which the right leg was immediately amputated. In April, 1917, he was struck in the left testis by a tennis ball, following which there was severe pain, but no swelling until August, 1917, or three months after the injury. The testis was removed on November 2nd, and the patient remained in the hospital for ten days. His general health was fair; had lost some weight.

Pathological report, by M. Schofield, M.R.C.S., Pathologist to the Royal Free Hospital, London, December 17, 1917: "Macroscopically, the specimen consists of a large, firm, oval tumor, measuring 4½ inches long and 3½ inches wide, by 3 inches thick, distending the cavity of the tunica vaginalis and partly adherent to the latter. The cord is attached to the upper and posterior part of the mass. The cut surface is firm and reddish-brown in color, except for an irregular, yellow, friable portion in the centre evidently necrotic. Microscopical sections show a dense cellular growth composed of large round cells, invading and entirely replacing the normal tissue of the testis. There is a marked chronic inflammatory reaction, especially at the spreading edge of the growth. In some parts the cells are very degenerate and the tissue completely necrosed, but in other parts many of the nuclei show mitotic figures indicating rapid growth. The appearance is that of a large round-celled sarcoma. Sections through the cut end of the cord show no malignant cells."

Physical examination at the time of my first observation, February 12, 1918, showed a patient rather thin but not emaciated, with good color. Examination of the groin and abdomen showed no palpable evidence of metastases. He was put upon the mixed toxins of erysipelas and bacillus prodigiosus, beginning with a dose of one-third minim and increasing up to the point of producing a marked reaction. The patient was very susceptible to the toxins, getting a temperature of 104° from three minims. He was never able to take over three to four minims during the entire course of treatment. In March, 1918, a massive dose of radium was applied at the Memorial Hospital, over the abdomen, two areas, 6207 mc. hours in each, at a distance of 6 cm. This produced intense nausea which lasted for several days. The toxins were continued with occasional intervals of rest. On September 17, 1918, a second application of radium was given over the same areas (upper and lower portion of the left abdomen), a total of 14,429 mc. hours at a distance of 10 cm. The patient then returned to England, where the toxins were kept up with occasional intervals for a little more than a year from the time the treatment was begun. The patient has remained in good health up to the present time with no evidence of a recurrence, four years and ten months later. In this case the slide was submitted to Dr. James Ewing, who pronounced it malignant of the type which he designates embryonal carcinoma. (Fig. 2.)

CONCLUSIONS

The number of permanent cures following surgical removal of the testicle for malignant disease, is comparatively small, the proportion being not over five to ten per cent. This number of cures, in our opinion, is not sufficiently

‡ Examination made July 25, 1923, showed patient perfectly well. No tumor in abdomen and X-rays of chest showed lungs normal.

increased by the radical operation of removal of the retroperitoneal glands by the abdominal route, to warrant the very considerable risk of such an operation.

Long-continued systemic treatment with the mixed toxins of erysipelas and bacillus prodigiosus, combined with thorough radiation of the abdomen and supraclavicular glands by radium or X-rays, offers a far better hope of a permanent cure than any form of operative treatment alone.

If one waits after operation until a recurrence has taken place, marked regression of these recurrent tumors, and in some cases complete disappearance, may be expected from radium treatment; but in the great majority of these cases, the regression or disappearance will prove only temporary and death from extension of the disease will occur.

Since this paper was read, further evidence of the value of the mixed toxins as a prophylactic after operation has been presented by Brickner (American Journal of Surgery, May, 1923); his report describes a man, forty years of age, who was operated on at the Mt. Sinai Hospital by Doctor Brickner on April 25, 1912. The tumor was of several weeks' duration, and was the size of a tangerine orange when removed. Three days later, an orchidectomy was performed, and the cord and testicle with its covering were removed *en masse*. Pathological examination by Dr. F. S. Mandlebaum: "a perithelial sarcoma, chiefly of large round cells, with pronounced evidences of malignancy." The mixed toxins of erysipelas and bacillus prodigiosus were administered from April 30 to June 18, 1912 (20 injections in all, the highest dose, 5 minims, producing a reaction of 100–01°). At the time of writing, the patient was in perfect health with no sign of a recurrence, eleven years later.

While in London in 1911, the author (Doctor Coley) saw in consultation, a young man, seventeen years of age, suffering from a large sarcoma of the testis, for which he advised immediate orchidectomy followed by toxin treatment. This was carried out, but no further report of the case was had until May, 1923, when he was again in London and saw the surgeon who had performed the operation; he then learned that the patient was still in good condition, twelve years later. The diagnosis in this case was confirmed by microscopical examination.

A personal communication just received from Dr. James T. Pilcher, of Brooklyn, mentions the end result of a case of tumor of the testis operated on by Doctor Pilcher in 1913; diagnosis by Doctor Murray of the Hoagland Laboratory of Long Island College Hospital: degenerate teratoma with both sarcomatous and carcinomatous degeneration; Doctor Lederer (Pathologist of the Jewish Hospital of Brooklyn) regarded it as a myxo-sarcoma of the testicle. This patient has remained in good health up to the present time, nine and one-half years later, without any prophylactic treatment following the operation.

REFERENCES

[1] Barringer: Transactions of the American Medical Association, Boston, 1920.
[2] Ewing: Teratoma and Its Derivatives. Surgery, Gynecology and Obstetrics, March, 1911.
[3] Schultz and Eisendrath: The Histogenesis of Malignant Tumors of the Testicle. Archives of Surgery, May, 1921, vol. xi, pp. 493–520.
[4] Bulkley: Surgery, Gynecology and Obstetrics, vol. xvii, p. 703, 1913.
[5] Sakaguchi: Deutsch. Zeitschr. f. klin. Chir., vol. cxxv, p. 294, 1919.
[6] Tanner: Surgery, Gynecology and Obstetrics, November, 1922.
[7] Chevassu: Revu de Chir., vol. xli, 1910.
[8] Coley: Cancer of the Testis. ANNALS OF SURGERY, July, 1915.
[9] Hinman: Jour. A. M. A., December 5, 1914.
[10] Hinman: Surgery, Gynecology and Obstetrics, May, 1919.
[11] Tanner: Surgery, Gynecology and Obstetrics, November, 1922.

EMPYEMA OF THE URETERAL STUMP FOLLOWING INCOMPLETE URETERECTOMY

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The literature dealing with the fate of the diseased ureter following nephrectomy is very scant, but few references having appeared on this subject. Recently, in a comprehensive article, Latchem,[1] of the Mayo Clinic, undertook, by animal experimentation, to study the question. A number of interesting observations were made which may be briefly summarized. Following a nephrectomy in which a normal ureter remained, it was found, that after a period of time averaging a little over a year, there was no tendency shown towards obliteration of the lumen of the ureter. There was, however, a distinct atrophy of its muscular layer. "The results obtained in the hydro-ureters and pyo-ureters depended entirely on whether or not the ureteral contents were evacuated. With drainage, the distended ureter became smaller through collapse of the lumen and atrophy of the muscle coat, and peri-ureteral inflammation did not occur. When obstruction to drainage was present, the muscular hypertrophy remained, and absorption of the ureteral contents seemed very limited, if occurring at all. Infection of the ureteral contents, if not present at the time of nephrectomy, occurred later in some instances, and always spread through the ureteral wall, to cause peri-ureteritis." Peri-ureteritis was present in every pyo-ureter in some degree, varying from inflammatory adhesions to abscess formation.

Judging from the scattered case reports, surgical interference for pyo-ureter is infrequently required. This may be due to the fact that the obstruction at the lower end of the ureter is seldom complete enough to prevent drainage of its contents. Israel [2] operated for this condition four times in a series of nine hundred kidney and ureter operations. Fowler [3] and the Mayo Clinic [4] have reported additional cases. Undoubtedly, a more extensive search of the literature would bring to light other such instances.

The condition which at present interests us differs somewhat from the ordinary pyo-ureter. It is in reality an empyema of the ureter stump which is occasionally left behind, following a ureterectomy. The term ureterectomy implies a removal of the entire ureter, down to its entrance into the bladder. A complete ureterectomy, however, is seldom performed; the lower inch or two of the vesical end of the ureter, the most difficult part to resect, being frequently left behind. The stump of ureter remaining may, when diseased, cause as much or more trouble than the major portion which was excised. The clinical course, and the cystoscopic picture of this condition, is in many respects, analogous to that of an infected vesical diverticulum, and the surgical treatment presents practically the same problem. The diagnosis of pyo-ureter of the ureteral

stump may offer some difficulties on account of its infrequency, and the inability to properly interpret the clinical and cystoscopic findings. The sequence of events is generally as follows: After a nephrectomy for a non-tuberculous renal suppuration, the pyuria persists, in fact may become more pronounced than it was prior to operation. Cystoscopy demonstrates that the pus comes from the dilated ureter. A ureterectomy is then performed, despite which the pyuria remains practically unchanged. Now unless a careful cystoscopic study is made, the source of the pus may be overlooked, for it is not generally recognized that the ureteral stump, left *in situ*, can be the cause of all the trouble..

The local pathological findings in our three cases may be thus summarized. The ureter stump, firmly embedded in dense adhesions, was found considerably thickened, and the walls infiltrated, as a result of which a marked peri-ureteritis was present. The ureteral lumen was considerably dilated, forming an elongated pouch, the contents of which consisted of thick pus which was extruded through the orifice, in tape-like pieces. In one case, besides the pus, there was found a considerable amount of calcified material. The ureter meatus in these three cases was almost occluded; in two instances, by a very pronounced inflammatory œdema, which completely obliterated the orifice from view, in the other case, the orifice was markedly contracted. The meatus in the first case was fibrotic, and so dense that it could not be cut through with the cystoscopic operating scissors. These findings correspond very closely to those reported by Latchem, in his animal experiments, and tend to corroborate clinically, his conclusions, that the lack of proper drainage, through the ureteral meatus, prevents emptying of its contents, and serves to prolong the suppuration indefinitely.

Clinical and Cystoscopic Features Noted in Three Cases.—The subjective symptoms are those of a pronounced cystitis. The urine, however, is more turbid and purulent than is usual in even a severe cystitis. Radiography of the urinary tract may reveal, as in one case, calcification within the ureter stump. Cystoscopic examination enables one to make an exact diagnosis. The ureteral orifice in all three instances was obstructed sufficiently to interfere with drainage. As a result, in one case, there was no pus observed coming from the meatus, and had the stump not been catheterized, the condition might very well have been overlooked. On introducing the catheter and on manipulating it in the stump, there was noted on its withdrawal, an escape of thick pus through the meatus, in the shape of a ribbon. The ureteral orifices could be catheterized only with the greatest difficulty, once on account of the marked œdema surrounding the meatus, in another instance the orifice had contracted to such a degree that it could only be identified by massaging the stump through the rectum, thus forcing out large clumps of pus. In two of the cases, the ureter catheter was introduced a distance of 6-8 cm., in the other over 25 cm., when a radiogram demonstrated that this was due to the fact that the catheter had coiled up on itself a number of times. At no time was peristaltic action of the meatus noted, although such an instance has been reported.

Radiograms taken with an opaque catheter in the stump, or after injection with bromides, show very distinctly the size and contour of the ureter.

The only satisfactory treatment is surgical, unless there are contraindications. Whenever possible, the stump should be excised. Its presence as a suppurating sac may in time lead to infection of the other kidney. This undoubtedly happened in the first case of our series. Palliative treatment consists in repeated dilatations of the meatus, or better still, the orifice may be divided with the operating scissors, or burnt through by fulguration; thus better drainage may be secured. At this point it may not be amiss to bring up the question of the proper disposition of the ureter, during the course of a nephrectomy for non-tuberculous affections. If the ureter is found but moderately diseased without evidences of any stricture, excision will not be necessary. A dilated, thickened infected ureter, especially if obstructed at its lower end, should be extirpated. It is very important that the entire ureter be excised, down to its entrance into the bladder, otherwise the stump left behind may continue to suppurate as in the cases under discussion.

Operative Technic.—It must be borne in mind that the extirpation of an ureteral stump is generally a difficult surgical procedure. The exposure is a deep one, the ureter as a result of the previous operation and the periureteritis is firmly embedded in the pelvis, closely adherent to the iliac vessels. The danger of a severe hemorrhage under such conditions is very great. There are two methods of approach, the first consists in mobilizing the bladder completely and then exposing the ureter, as is done in the operation for resection of the bladder for malignancy. The adhesions may be so dense that it may be impossible to obtain an exposure by this route. The second method is to open the bladder, introduce a probe through the diseased orifice, and identify the ureter in this manner. The former procedure is probably the better one, the incision being the usual one employed for the extra-peritoneal exposure of the ureter. To facilitate dissection of the ureter, it will be found advisable to start from below, that is, from the uretero-vesical juncture, where it is likely to be less diseased and less adherent, and gradually work towards the upper end of the stump. When the latter is firmly attached to the iliac vessels, it may be advisable to resect only a short piece. Under these circumstances, as much of its anterior and lateral wall as possible should be removed, the mucosa of the remaining portion thoroughly curetted and carbolized. A suprapubic cystotomy should complete the operation; this will diminish the danger of leakage through the ureteral orifice, with consequent infection of the periureteral tissues.

The following three cases of empyema of the ureter stump have been observed during the past ten years:

CASE REPORTS

CASE I.—M. M., age forty-six, male. Admitted to Mt. Sinai Hospital (service of Doctor Beer), May, 1912, with the following history. Nine years ago his right loin was incised and a perinephric abscess drained. The sinus refused to

close, and a few months later, a right nephrectomy for pyonephrosis was performed. Following this operation, a suppurating lumbar sinus persisted, and the urine remained very turbid; to cure this condition, a ureterectomy was performed. The ureter was difficult to locate on account of the dense adhesions. It was markedly thickened and dilated, and resected down to within a very short distance of its entrance into the bladder. Packings were freely used for drainage and to control bleeding; on removing these a fecal fistula developed, which required

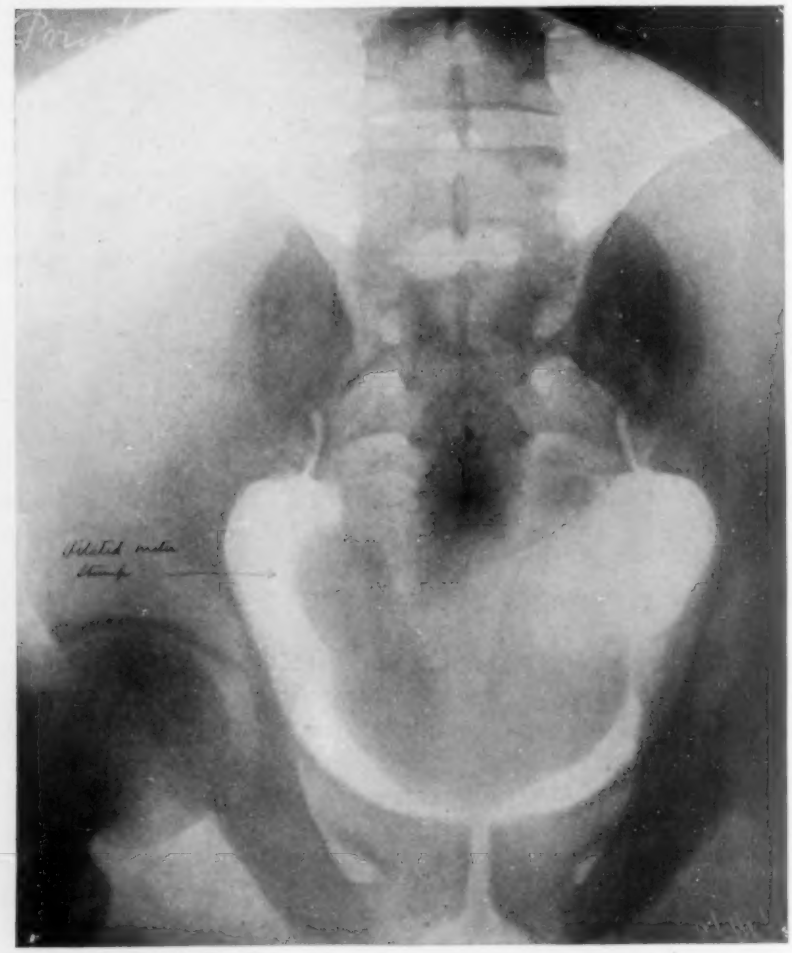

FIG. 1.—Case I, after injection of pouch with argyrol.

another operation before it was finally closed. The patient was readmitted to the hospital a short time after, on account of the marked pyuria, which had not been influenced by the ureterectomy. It was decided at the time, that the stump of the ureter left behind was the source of the trouble, and an attempt was made to extirpate the remaining portion of the ureter. The sacral route was used, part of the coccyx resected, and after considerable difficulty, what was thought to be the ureteral stump, was excised. Microscopic examination proved this to be a diseased seminal vesicle. Since the last operation, eight years ago, he has at different intervals complained of diurnal and nocturnal frequency, severe burning at

beginning and end of urination. The urine has been very turbid, and has contained large clumps of white material. He complains of pain in both loins, aggravated on defecation.

Physical Examination.—May, 1921, shows a man in good general condition. In the left hypochondrium there is a hard, firm mass, tender on deep pressure, and which moves with respiration. On rectal examination, the prostate is found moderately enlarged. On the right pelvic wall there is a hard mass, the size of an olive, not movable or tender. The urine is turbid. P. S. P. test 50 per cent. in two hours.

Cystoscopy.—The bladder is markedly inflammed, with areas of œdema and leukoplakia. At the site of the right ureter there is a firm polypoid œdematous

FIG. 2.—Case I showing coiling of catheter in pouch.

mucosa, and protruding from the orifice, a mass of purulent exudate. Corresponding to the site of the left ureter, there is an opening one-half cm. in diameter, with a circular, smooth edge, resembling the orifice of a large diverticulum. A ureteral catheter was introduced a distance of 14 cm. on this side, whereas, on the right side, a catheter was introduced 25 cm. Indigo carmine appeared in thirty-eight minutes after injection, from the left ureter, none from the right side. On irrigating the right ureter, thick, foul pus was washed out. A diagnosis was made of empyema of the right ureter stump, and it was thought that the left ureter was either enormously dilated, or emptied into a large diverticulum, in which the catheter coils up. A week or so later, the patient was recystoscoped with similar findings. An X-ray catheter was introduced into the right ureter, and argyrol injected. The radiograms distinctly showed a large pouch on the right side, this pouch being the dilated stump of the ureter. Within the pouch the catheter can be seen coiled up (Figs. 1 and 2).

Operation.—June, 1912 (Doctor Beer). A catheter was first introduced into the ureter stump. A right rectus incision, six inches long, was made, running

obliquely towards the median line. The fascia was incised, rectus pushed aside, and the perivesical fat was incised. Alongside of the bladder, and firmly adherent to the pelvic floor, the posterior abdominal wall and vas, and remains of the seminal vesicle on this side, there was found a hard mass, almost tumor-like in consistency and about five inches in circumference. Its length could not be ascertained, owing to the fact, that its upper limits could not be determined. This mass which was the dilated, infiltrated, diseased ureter stump, was so firmly embedded and bound down by adhesions, that it was impossible to free it. During manipulations, the peritoneal cavity was opened, and there was considerable venous oozing, so that the attempt to remove the ureter stump had to be abandoned and the wound packed, to control the bleeding. The patient recovered from this operation, but the purulent condition of the urine remained unchanged. Later on, attempts were made to incise the orifice with an electric cautery scissors, but on account of the fibrosis present, this could not be accomplished. The patient lived for about five years, and then succumbed from an infection of the other kidney.

There are a number of points of interest in this case. The surgeon who did the first ureterectomy was under the impression that he had excised the entire ureter, whereas, about two inches was left behind. In attempting to remove the stump of the ureter, the sacral route was chosen, resecting the coccyx. The operator was under the impression that the piece excised was the stump, in reality it was found to be a diseased seminal vesicle. Then a third attempt was made to excise the stump anteriorly, and it was found so firmly embedded, that a serious hemorrhage was encountered trying to free it, and the attempt at removal had to be abandoned.

Case II.—N. B., male, age, twenty-nine, was admitted to Mt. Sinai Hospital, March 28, 1918, with the following history. His illness began a year and a half ago with frequent urination, nocturia, polyuria and pain in the back. Following an injection of salvarsan, six months ago, he developed anuria, with fever, chills and sweats. A diagnosis of right pyonephrosis was made, following which his right kidney was opened and drained. Since then, besides voiding naturally, he has passed large amounts of urine through the drainage tube, which is still *in situ*. He comes to the hospital on account of the urinary symptoms above noted, and to determine the cause of his persistent pyuria.

Physical examination shows a poorly nourished individual. On abdominal examination, both kidneys are distinctly enlarged. The urine is purulent. P. S. P. test 24 per cent. in two hours. Blood chemistry shows moderate retention of urea and nitrogen; X-rays of urinary tract, negative.

Cystoscopic examination demonstrates a moderate cystitis. No urine was obtained from the right kidney; which drains through the nephrotomy tube. Turbid, foul smelling, purulent urine was obtained from the left kidney. Indigo carmine did not appear within an hour after injection, from this side. A diagnosis of left pyonephrosis was made, and at operation an atrophic, pyonephrotic kidney, with very little parenchyma, was found. In view of the diseased kidney on the other side, it was deemed inadvisable to do a nephrectomy, and accordingly, the kidney was drained. The patient improved after this operation, and left the hospital with drainage tubes in both kidneys.

The patient was readmitted, January 15, 1919, on account of painful, frequent urination, and pyuria. Cystoscopy showed an inflammed bladder. The left ureter was obstructed at 2 cm., and no urine was obtained; the right ureter was unobstructed, and cloudy urine was withdrawn. Capacity of right pelvis, 60 c.c. Wassermann negative. Palliative treatment was instituted and the patient was

referred to the out-patient clinic. He was again readmitted for the same urinary symptoms, six months later. At this time it was noted that some of the voided specimens of urine contained a thick creamy pus which was found to come from the left kidney. The left kidney was extirpated; it was found totally destroyed, the ureter considerably thickened and dilated, and adherent to surrounding tissues. Following this operation the character of the urine remained unchanged. The final discharge note reads as follows. From time to time the patient passes from six to eight ounces of thick, creamy, foul smelling pus. On catheterizing his ureters, it was found that this pus came from the dilated left ureter, which was obstructed at 2 cm. The patient was readmitted in August, 1919, complaining of passing thick, foul smelling pus a number of times during the day. It was determined again by cystoscopy, that the source of this thick pus was the left ureter. Accordingly, on August 14th the left ureter was excised through a para-rectus incision. A very thick dilated ureter, filled with green pus, was found and excised down to what was thought to be its lower end. The operation was very difficult technically, on account of the dense adhesions surrounding the ureter. Microscopic examination showed a thick, necrotic ureter, with infection of all its coats.

The patient again returned to the hospital a year ago, August, 1920, complaining of difficulty in voiding, with passage from time to time, of six to eight ounces of foul smelling pus as before the previous operation (ureterectomy). His condition at this time was rather poor. The urine draining through the right nephrotomy wound was somewhat cloudy, with 25 per cent. P. S. P. in two hours. The voided urine, containing thick, foul smelling pus, had but 6 per cent. P. S. P. Cystoscopy showed an inflamed trabeculated bladder. The right ureter orifice was normal. Slightly cloudy urine was obtained from this side. The left ureter orifice was considerably contracted, and was catheterized for a distance of 6 cm. No pus was observed coming from the orifice before the introduction of the catheter. On removing the catheter, a stream of thick pus was seen to escape from the ureter stump. This procedure was repeated a few times with similar findings, long, tape-like masses of pus being passed. It was definitely determined that the source of the pyuria was the left ureter stump, which was approximately 6 cm. long. On account of the patient's poor condition, operation was not deemed advisable.

The patient was readmitted to the hospital four months later, February 11, 1921. As on the last two admissions, most of the urine was drained through his nephrotomy tube, a few times a day he would void about four to six ounces of thick pus. Cystoscopy showed findings similar to those obtained at previous examinations, that on withdrawing the catheter from the left ureter stump, there was a gush of thick pus. Post-urethroscopy demonstrated a picture similar to that found in contracture of the neck of the bladder, namely, supramontane swelling with thickening of inferior lid of sphincter. The residual urine varied between one and three ounces. The case was considered one of contracture of the neck of the bladder, with secondary infection and destruction of the kidneys. It was not considered advisable to attempt removal of the stump, as it would most likely be a formidable procedure on account of the dense adhesions, due to previous operations. In view of the fact that the right kidney is a pyonephrotic organ, its drainage was continued so as to control the infection with renal lavages. The patient was readmitted to Mt. Sinai a few weeks ago, February, 1923, for further study. His general condition now is very poor, he looks emaciated, and is markedly anemic. About fifteen to twenty ounces of turbid urine are voided daily, while about forty to fifty ounces drain through the nephrotomy tube. Blood chemistry shows moderate retention; the phthalein test of the combined voided and drained urine equals 40 per cent. for six hours.

Cystoscopic examination demonstrated a considerably inflamed bladder. The right meatus is normal, the left cannot be seen. On introducing a finger into the rectum and stripping along the course of the ureter, there was noted a thick, tape-like pus issuing from what was evidently the ureteral orifice. With this as a guide, a catheter was inserted a distance of 5 cm. The introduction of the catheter evidently loosened up a good deal of pus, which poured out of

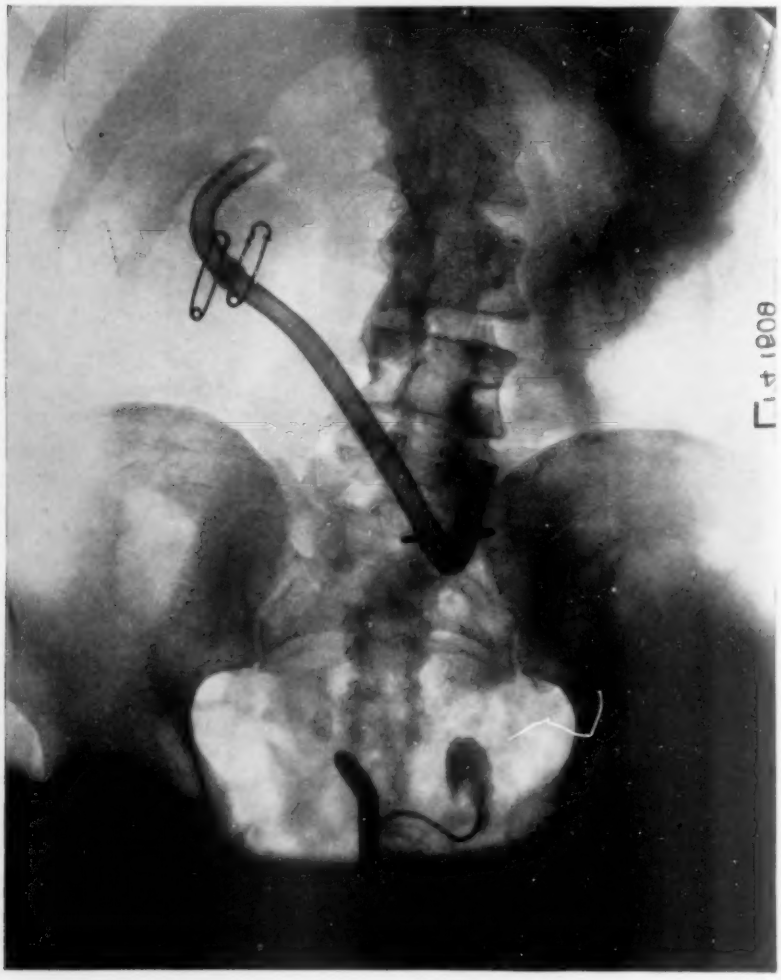

FIG. 3.—Case II, showing dilated ureter stump.

the orifice on withdrawing the catheter. An ureterogram was then taken, showing very distinctly the dilated ureter stump (Fig. 3). On account of his poor general condition, it is not considered advisable to attempt removal of the stump.

CASE III.—J. P., age twenty-six years, single, was admitted to Mt. Sinai Hospital (service of Doctor Beer), November 12, 1922, complaining of burning urination, pyuria, passage of fine calculi in the urine, and a persistent sinus in an abdominal scar. The patient gave a history of having been operated fifteen years ago, in Russia, for a right ureteral calculus. Five months ago he was operated upon in another hospital for a right pyonephrosis, due to an impacted

ureter calculus. The kidney was found to be entirely destroyed. The ureter which was found considerably dilated was brought up to the skin and sutured in place, a large tube being passed down its lumen. Following this operation, the local condition did not improve, the pyuria persisted, and a sinus which formed at the site of the ureteral attachment to the skin, kept on discharging pus.

The patient was reoperated at the same hospital, about five weeks later, the ureter being excised down to the iliac vessels. It was impossible to remove the

FIG. 4.—Case III, showing longitudinal shadows in lower portion of right ureter.

remaining portion, owing to the dense adhesions and the patient's poor condition. The shadow in the ureter which was thought to be a calculus was found to be inspissated sand.

Following this operation there was no improvement in the condition of the urine which continued to be very purulent. The patient now complains of burning pain on urination, with the passage of granular material in the urine. He also has pain in the right side of the abdomen, along the course of the ureter, and a discharging sinus in the anterior ureteral wound.

Physical examination shows a rather poorly developed individual. There

is a right lumbar scar, also an anterior ureteral scar, in the lower end of which there is a small discharging sinus. A large exudate can be palpated in this region. Urine is purulent. P. S. P. test 20 per cent. Blood chemistry, normal. Radiograms show irregular longitudinal shadows in the region of lower portion of the right ureter (Fig. 4), which were interpreted as calcification within the ureteral stump.

Cystoscopy (Dr. A. Hyman).—Bladder considerably inflamed, with muco-

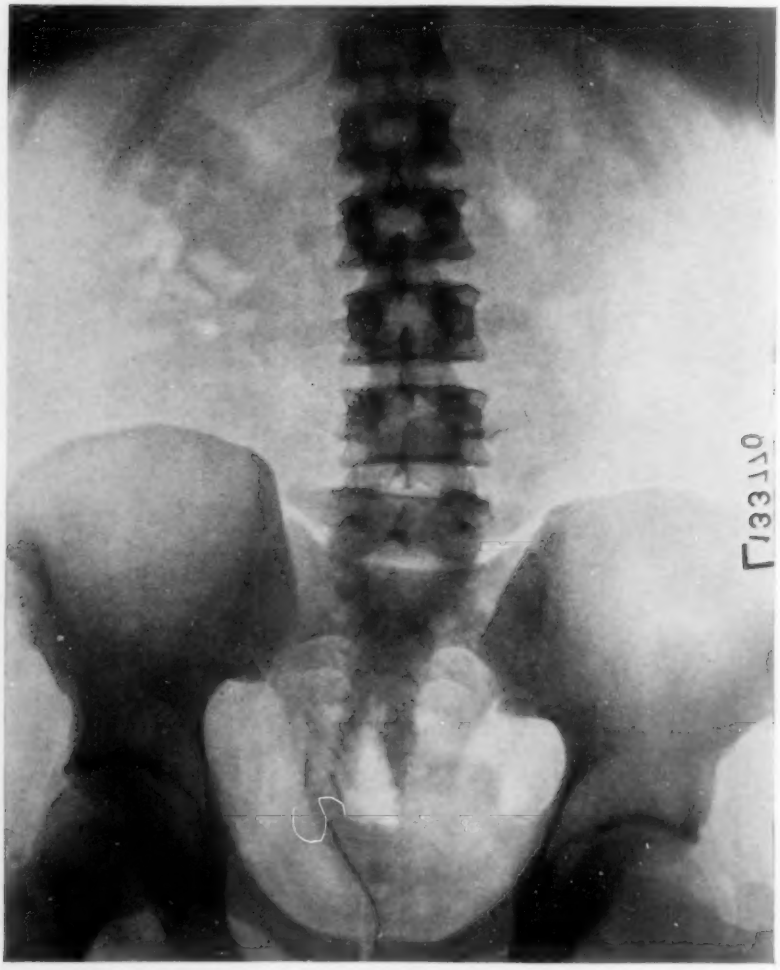

FIG. 5.—Case III. Demonstration by use of opaque catheter. The shadows noted in Fig. 4 are within the ureter lumen.

pus adherent to base. The right ureteral orifice is so markedly swollen and œdematous, that its opening cannot be seen. Thick, tape-like pus is seen issuing from the centre of this area of œdema. An opaque catheter was passed after considerable difficulty for a distance of 7 cm.; the radiograms taken with an opaque catheter *in situ* demonstrated the shadows previously mentioned to be within the ureter lumen (Fig. 5). Clear urine with good function was obtained from the left kidney. A diagnosis was made of suppurative calcified ureter stump, and the persistent pyuria was attributed to this condition.

Operation.—October 18, 1922 (Doctor Beer). Median suprapubic incision, bladder mobilized completely, and ureter exposed. It was found to be enormously thickened, a full one and one-half inches in diameter, and firmly adherent to the floor of the pelvis. The lower end of the ureter was first dissected free and followed up as far as possible, and liberated for a distance of two and one-half inches. The upermost end, about one-half to three-quarters inch long, was too firmly embedded to allow of safe dissection. The mobilized part with the adjacent bladder wall, including the orifice, was excised. The anterior and lateral walls of the upper end which could not be freed were resected and the lumen was thoroughly curetted to destroy the mucosa and then carbolized. The ureter was found to be distended with pus and a large amount of soft calcified material. Suprapubic drainage was then instituted and an iodoform gauze drain introduced into the small pocket which represents the upper end of ureteral stump denuded of mucosa.

The patient made a rather uneventful convalesence, the only complication being a pelvic exudate, which developed a few weeks later, this cleared up entirely under hot rectal irrigations. The exudate in the region of the scar disappeared soon after operation. When discharged from the hospital, three weeks later, the urine was perfectly clear, the abdominal sinus had ceased discharging, and the wound was firmly healed. A small stone was spontaneously voided a short time after operation, this had no doubt been expressed from the ureter into the bladder, during the operation. The pathological report of the ureter showed fibro-muscular tissue, with many foci of infiltration.

These three cases conclusively demonstrate that the ureteral stump left behind after an incomplete ureterectomy may be the cause of a persistent pyuria. Two of the cases operated upon also revealed how difficult a surgical procedure it is to excise this stump, and emphasizes the necessity, when doing a primary ureterectomy for pyo-ureter, to excise the entire ureter down to its entrance into the bladder.

REFERENCES

[1] Latchem, R. L.: Journal Urology, No. 3, September, 1923.
[2] Israel: Quoted by Fowler.
[3] Fowler, H. A.: Trans. Amer. Association G. U. Surgeons, 1910, vol. xxxv, p. 49.
[4] Mayo Clinic: Report by Latchem, Journal Urology, No. 3, September, 1923.

RUPTURE OF TENDON OF EXTENSOR LONGUS POLLICIS FOLLOWING A COLLES FRACTURE*

By Astley P. C. Ashhurst, M.D.
of Philadelphia, Pa.

Under the title of "periarthritis" used originally by Duplay and other French surgeons, it is convenient to group a number of lesions, of which one is the so-called spontaneous rupture of tendons. This occurs most frequently, perhaps, at the shoulder joint; the long tendon of the biceps, as pointed out by Gwilym G. Davis,[1] may give way under comparatively slight strain because already diseased or bound down by adhesions in the bicipital groove. Davis quotes from Robert Adams,[2] a description of the diseased state of the tendons about the joints usually found in this disease. The first case of subcutaneous rupture of one of the wrist tendons, appears to have been reported by Duplay,[3] whose patient, a woman thirty-six years of age, and a cane-maker, suffered a rupture of the extensor longus pollicis tendon in a fall. Duplay sutured (by one metallic suture, later removed) the peripheral end of the long thumb extensor to a buttonhole made in the "premier radial externe" (extensor carpi radialis longior), because of the impossibility of end-to-end union, the ruptured ends being separated by a distance of 6 cm. Excellent function was secured within a couple of months in spite of the rather free suppuration which preceded final healing of the wound.

This case of Duplay's, however, was clearly traumatic, and there is no reason to believe the tendon was predisposed to rupture from intrinsic disease or from any form of periarthritis at the wrist. As such a complication of preceding disease, it seems to have been recorded first by German military surgeons, who, according to Steudel, have recognized, since the early eighties of the nineteenth century, an affection called "Trommlerlähmung" or Drummer's Paralysis. It results from chronic tenosynovitis produced by the peculiar method of holding and using the left drumstick. The rupture is said to occur usually during a paroxysm of drumming, or more rarely quite spontaneously. It is said to occur usually in beginners and to affect the left hand rather than the right. The subject was carefully reviewed in 1891 by Von Zander,[4] who concluded it was an incurable condition; the drummers so affected in almost all cases had to be discharged from the army. He reported nineteen cases where the extensor longus pollicis was affected, and two in which the flexor longus was ruptured. A more recent study of the subject is that by J. Ramsay Hunt,[5] in whose own patient, a tailor, who did heavy sewing and ironing for long periods, the rupture occurred almost spontaneously, while he was feeling around in his pocket for some articles. Hunt says his case is the only one in American literature; but he has overlooked the report of

* Read before the Philadelphia Academy of Surgery, January 8, 1923.

Scudder and Paul,[6] whose patient sustained an apparently spontaneous rupture of this tendon some weeks after a fall on the hand which had caused only temporary disability. They operated by a modification of Duplay's method: finding it impossible to secure end-to-end union, the tendon of the extensor carpi radialis longior was split and one-half of it united to the peripheral end of the thumb tendon. A useful thumb, but not full power of extending the distal phalanx, was present eight months after operation.

Rupture of the extensor longus tendons to the fingers has occurred also; in Melchior's[7] patient it was attributed to gonococcic tendovaginitis.

Among the less usual causes for rupture of the long extensor of the thumb, is a Colles fracture. It is strange, indeed, that this lesion is not a more frequent sequel of fractures around the wrist, since the tendons on the dorsum, especially that of the long extensor of the thumb, lie in very deep grooves against the bone, and it seems that they should very easily be caught by adhesions, under which circumstances a so-called spontaneous rupture might easily occur.

CASE REPORT

On March 20, 1922, Lt. Comm. John T. Bennett, U. S. N., brought to consult me his colleague, Dr. C. S. N., thirty-one years of age, with the following history: On January 24, 1922, Dr. N. had fallen on his over-extended left wrist, breaking the radius close to the joint; there was scarcely any displacement shown by the X-ray, and a splint was worn only as a matter of form, for a period of two weeks. He then gradually resumed his surgical work. About the first of March, after being engaged in an especially difficult operation, in which considerable retraction of the wound edges was required; and after having been occupied rather long hours in anatomical dissections; he noticed some pain for a few days in the radial region of the left wrist. Later the pain became very severe. It seemed as if there was tenosynovitis on the dorsum of the wrist, but no crackling could be detected. He wore a splint again for a while.

Examination showed complete loss of function in the extensor longus pollicis, as evidenced by inability to extend the distal phalanx on the proximal or to make the tendon contract visibly in its normal course below the wrist. The extensor brevis and all other tendons acted normally. The patient told me he had tested the forearm muscles with the faradic current, and that no contraction of the long extensor could be secured, though all other muscles reacted.[8] He also called my attention to the statement in DaCosta's Surgery[10] that rupture of the long thumb extensor "sometimes occurs, apparently spontaneously, a number of weeks after the occurrence of Colles fracture."

The diagnosis and the cause of the lesion being recognized, operative repair of the tendon seemed indicated. Certainly end-to-end suture of the tendon was

[8] Hunt went to quite unnecessary lengths, it seems to me, to prove the condition was not due to a nerve lesion, but caused by an actual rupture of the tendon. He claims that the extensor longus pollicis and the extensor indicis are jointly innervated by a single small branch of the posterior interosseous, and that neural paralysis of one muscle without that of the other is unknown. But in Cunningham's Anatomy[9] is an illustration of these nerves showing the branch to the extensor indicis arising from the main trunk of the dorsal interosseous much nearer the elbow than the branch to the extensor longus pollicis, which arises entirely independently from the main trunk some distance lower down. These facts I have verified on the cadaver.

to be preferred; but in case this should prove impossible, it was determined to fasten the peripheral end of the ruptured tendon to some other tendon in the neighborhood, either one of the other thumb extensors, as advised by Hunt, or one of the radial extensors of the carpus.

Operation was undertaken at the Orthopædic Hospital, on March 25, 1922. Under local anæsthesia (one-quarter per cent. novocain) an incision 10 cm. long was made over the course of the tendon from below the annular ligament up over the forearm. The peripheral end of the tendon was easily found, just below the annular ligament, and very loosely attached. The proximal end was difficult to identify but was finally found on the radial side of the extensor indicis just above the annular ligament. It was densely adherent to callus in its radial groove, and above this point was quite frayed out. The distal end had ruptured transversely just below the adherent point; evidently the flexor tendons, during strong grasping movements, had pulled the distal end of the tendon free from its anchorage, while the contractions of the extensor longus pollicis itself had not been able to pull the proximal end loose. The ends of the tendon were united, end-on, by three chromic catgut sutures No. 0; the annular ligament covering the tendons of the extensor communis digitorum was repaired over them where opened in the search for the adherent proximal end of the ruptured tendon; but the tendon of the extensor longus pollicis was not replaced in its groove next the bone, nor was any attempt made to remove the scar tissue in this deep groove, as it was thought any such attempt would lead to more dense adhesions. The deep fascia, however, was carefully sutured over the reunited tendon so as to prevent it from riding away from the bone, like a bow-string. Finally the superficial fascia and the skin were each closed separately with No. 00 chromic catgut. A moulded gypsum splint was applied to the flexor surface of the hand and forearm, keeping the latter in full supination, with the fingers and thumb in hyperextension, and the wrist in abduction.

The first dressing was made April 15, 1922, three weeks after operation: the wound was healed and the skin sutures absorbed. The patient was able to flex and to extend gently the terminal phalanx of the thumb. The gypsum splint was shortened to allow the four fingers free motion below the metacarpal joints, but keeping the thumb still in hyperextension. I advised that after five weeks from operation a splint to support the thumb should be worn, at night only, for three or four weeks longer, when I thought active use of the thumb should be encouraged. Under date of October 29, 1922, the patient wrote: "the function of my left thumb has entirely returned. I kept the thumb splinted until the middle of June. It was very stiff and painful for another month but since then I have been going about my usual operative work and now notice no disability."

REFERENCES

[1] Davis, Gwilym G.: Trans. Coll. Phila., 1895, vol. xvii, p. 73.
[2] Adams, Robert: Rheumatoid Arthritis, 1873.
[3] Duplay: Bull. Soc. Chir. Paris, 1876, vol. ii, p. 788.
[4] Von Zander: Inaug. Dissert., Berlin.
[5] Hunt, J. Ramsay: Jour. Am. Med. Assoc., 1915, vol. lxiv, p. 1138.
[6] Scudder and Paul: Boston M. and S. J., 1903, vol. cxlix, p. 653.
[7] Melchior: Berl. klin. Woch., 1916, Bd. liii, S. 139.*
[8] Hunt, J. Ramsay: *Loc. cit.* See footnote on previous page.
[9] Cunningham's Anatomy, London, 1922, 5th Ed. p. 741, Fig. 613.
[10] DaCosta: Surgery, 8th Ed., Phila., 1919, p. 810.

*This reference has not been accessible.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held March 5, 1923

The President, Dr. John H. Jopson, in the Chair

ACUTE INTESTINAL OBSTRUCTION DUE TO IMPACTED ASCARIDES LUMBRICOIDES

Dr. James A. Kelly presented a girl ten years of age, who was admitted to St. Mary's Hospital, November 6, 1922, with primary diagnosis of appendicitis (acute) and diffuse peritonitis. On admission temperature was 100, pulse 120, and respirations 136. She had been indisposed for about two weeks, complaining of nausea, anorexia and constipation. These symptoms increased, until the day before admission, when the patient was unable to have a bowel movement, became very restless and abdomen became rigid, tender and distended. Physical examination on admission showed a moderate degree of abdominal distention with generalized tenderness, particularly marked over right lower quadrant of abdomen. Patient vomited after admission, vomitus consisting of dirty, grayish-black material, and fetid, which was not fecal in character. Under ether anæsthesia examination of abdomen showed considerable relaxation and the presence of several masses, suggesting a diagnosis of acute intestinal obstruction, acute appendicitis or tuberculous peritonitis. Examination of urine negative. Blood examination showed red blood cells 4,100,000, white blood cells 11,400 and hæmoglobin 90 per cent. Differential blood count polymorphonuclear leucocytes 80 per cent., large and small lymphocytes 20 per cent. No eosinophiles.

Operation.—Through a four-inch median line incision below umbilicus the abdominal cavity was opened and about six ounces of clear peritoneal fluid was found. Exploration showed two portions of the small intestines completely filled with irregular masses extending in one portion for a distance of eight inches and in another portion for a distance of twelve inches. Through two enterostomy openings the masses were removed and found to be closely packed groups of ascarides lumbricoides. The enterostomy openings were closed, a cigarette drain was placed in the pelvis and the abdomen closed by layered sutures. Patient made an uninterrupted surgical convalescence, and was later referred to medical service for the treatment of intestinal worms. The number of ascarides lumbricoides removed was one hundred and fifty-four. Examination of the fæces showed innumerable eggs of the above-mentioned parasite. Patient was discharged six weeks after entrance and at present date, March 1, 1923, has had no further trouble, although eggs are still present in fæces.

INCISED WOUND OF THE FOURTH AND FIFTH CERVICAL NERVES

DOCTOR KELLY presented a man, thirty-eight years of age, who was admitted to St. Mary's Hospital, June 27, 1922. This man on June 1, 1922, while doing some repair work at home, was standing on a table holding a putty knife. The leg of the table broke, throwing him to the ground, the putty knife piercing his neck. In the emergency room he was given a careful examination, laceration over right sterno-mastoid muscle being the only injury. Five sutures were inserted. When seen in his room he complained that his arm was numb from the shoulder (right) down, only motion he was capable of was at the wrist. Further examination showed palsy of right arm and forearm, slight numbness of right thumb. Inability to raise right arm or forearm. Flexes and extends finger and wrist. No wrist drop. Has power of partial pronation and supination. Grip in right hand good.

Motor Phenomena.—All motor power except flexion and extension of fingers and wrist and partial pronation and supination of arm and forearm lost. Cannot raise arm or forearm from bed.

Sensation.—All sensation, both superficial and deep in fingers, hand, forearm, and lower one-third of arm O. K. Almost complete anæsthesia over deltoid and lower portion of trapezius muscles, certainly superficial sensation completely lost. (Fig. 1.) Deep sensation impaired below deltoid to about middle of third of arm. There is undoubtedly a lesion in the cervical plexus, probably a partial severance of the fourth and fifth cervical nerves, affecting the spinal branch of the spinal accessory nerve, which supplies the circumflex which also begins at the fifth cervical nerve and supplies the deltoid.

Diagnosis.—Lesion of the cervical plexus, probably affecting the fourth and fifth cervical nerves and in all probability a severed nerve or partially so, rather than a hemorrhage, since the patient had a complete loss of function from the time of injury.

Operation.—Temporary sutures removed from wound of neck. It was then found that the skin incision was continuous with and parallel to the fibres of the sterno-mastoid muscle, just outside of the carotid sheath. This wound was enlarged through the sterno-mastoid muscle and after considerable difficulty and deep retraction there was found a complete severance of the right fourth and fifth cervical nerves. (Fig. 2.) This wound was so close to the vertebra that the periosteum from the right lateral process of the fourth cervical vertebra was chipped off. The cut ends of both nerves were approximated by two interrupted sutures of fine silk and the wound closed without drainage. Patient made an uninterrupted convalescence, and was in the hospital twenty-six days.

Condition six months later; examination by Dr. M. A. Burns, December 29, 1922.

Motor Phenomena.—Patient has a partial palsy of upper right extremity. Grip good, unable to abduct arm very well, seems to annoy him at shoulder joint. Able to adduct very well and seems to have considerable power performing this movement; unable to flex forearm

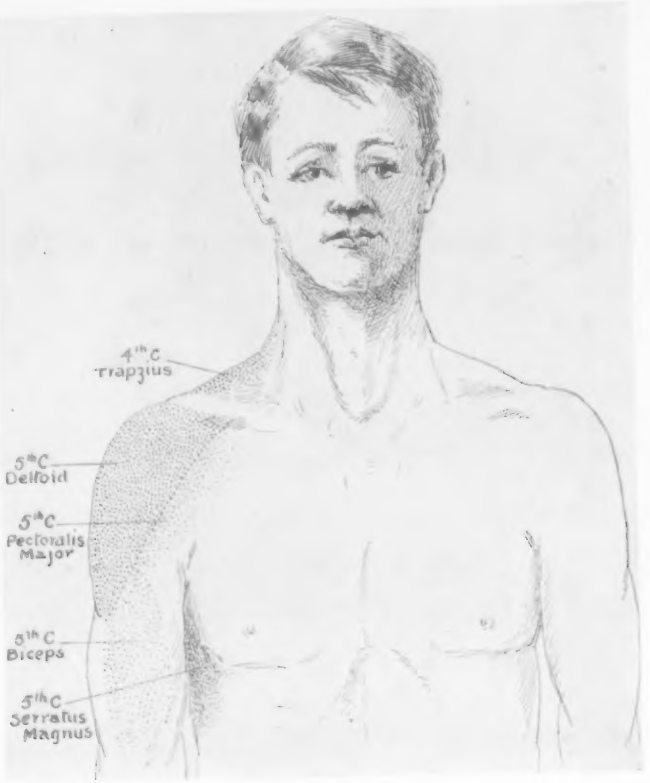

FIG. 1.—Showing area of distribution of muscular paralysis and loss of sensation.

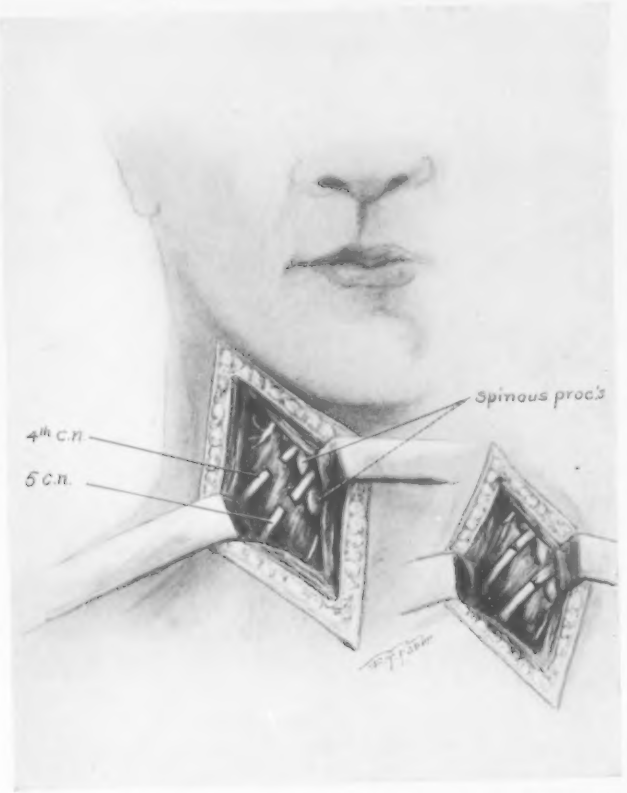

FIG. 2.—Case II, shows retraction of primary wound of skin, fat and sterno-mastoid muscle, exposing the severed ends of the fourth and fifth cervical nerves. Insert shows method of repair.

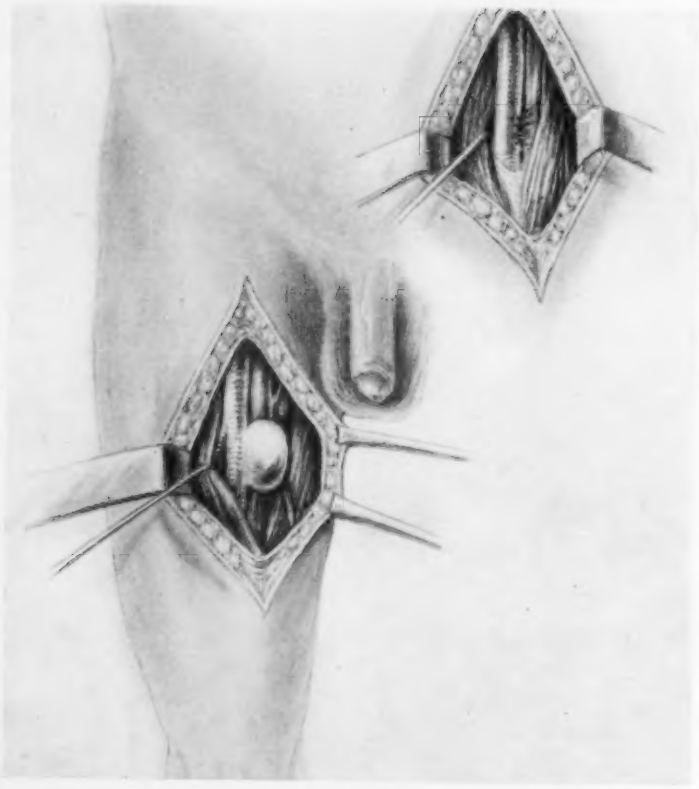

FIG. 3.—Case III, shows formation of traumatic aneurism. The sac was readily removed from the artery and the wound of artery closed by four interrupted sutures, as shown in insert.

without aid of other hand, but after he gets forearm up, he can use hand very well. There is no evidence of wrist drop. The forearm is unusually well developed, but his arm shows evidence of considerable atrophy, especially over the deltoid and trapezius muscles. Patient still unable to raise arm of itself, but has considerable power in it after he flexes it with the aid of the other hand.

Sensation.—Sensation is normal over deltoid, and almost normal over the trapezius muscles, except there is some slight diminution in sensation just around the insertion of the deltoid. There is a very marked degree of sensation returned and perfectly normal over deltoid and trapezius, and also a marked increase in motor power, although there is some palsy still remaining.

Electrical Reactions.—It is impossible to take the electrical reactions at this time.

March 1, 1923.—Muscular power slowly increasing. Muscular atrophy disappearing. Patient has been able to drive his automobile for the past two months.

BULLET WOUND OF THE THIGH PRODUCING TRAUMATIC ANEURISM OF FEMORAL ARTERY

Doctor Kelly presented a man, twenty-three years of age. who was admitted to St. Mary's Hospital, October 31, 1922, suffering with bullet wound of the right thigh, accidentally received.

Examination on admission showed a bullet wound of the right thigh with wound of entrance on surface of thigh about the middle and in the line of the femoral vessels. Wound of exit on posterior surface of thigh level as wound of entrance. Considerable bleeding had taken place, but the patient was not in condition of extreme shock on admission. Wound of entrance and exit thoroughly cauterized and dry, sterile compression dressing applied and a prophylactic dose of anti-tetanic serum administered in the receiving ward. Blood examination on admission showed red blood cells 4,150,000, white blood cells 10,600 and hæmoglobin 80 per cent. As there was present pulsation over the popliteal artery after admission, it was considered probable that the femoral artery was not injured. The patient was carefully watched and after the sixth day there began to take place an evening rise in temperature, accompanied by a localized swelling around the wound of entrance.

Operation.—Ten days after admission, under gas anæsthesia, an incision was made through the wound of entrance, with the idea of probably evacuating a localized collection of pus. There was a considerable spurt of bright red blood. The wound was hurriedly packed with gauze and a tourniquet applied high up on the thigh. The gauze was then removed, the wound enlarged and the femoral vessels exposed. Surrounding the site of the femoral artery there was an organized blood-clot in the form of a saccular aneurism. This was carefully removed and it was then found there was a wound of the inner portion of the femoral artery, with a loss of about one-quarter of its calibre (Fig. 3). Four interrupted lateral sutures of fine silk were then used

to close the wound of the femoral artery and a small rubber tissue drain introduced to the site of the suture. Upon removing the tourniquet pulsation was then noticed in the femoral artery below the line of suture and there was no leakage from the line of suture. The wound was then closed in layers except at the point of rubber tissue drainage. The drain was removed on the fourth day and the patient made an uninterrupted convalescence. At no time during the convalescence was there noticed any evidence of obstruction at the line of suture. Examination on March 1, 1923, shows wound entirely healed and the only symptom the patient complains of is a slight referred pain down the thigh to the knee.

Dr. Astley P. C. Ashhurst said that about a year ago, in reporting to this Academy a somewhat similar case, Doctor Muller brought up the question as to whether or not in civil life it was proper to explore such wounds without waiting for the further development of symptoms. Doctor Muller said that all authorities taught that one should not operate unless there was active hemorrhage at the time. This is of course according to the traditional rule; and it does not appear that either Doctor Muller's patient or Doctor Kelly's patient suffered any harm as a result of delay in the operation. They did right in delaying it, because there was no proof that any large vessel was injured. The presence of pulsation below at the time of injury is in accordance with what was seen during the war, when with no bleeding from the wound and continued pulsation in the peripheral branches, exploration sometimes revealed injury to the vessel; the French surgeons well described these cases as "lesions sèches" of the arteries.

At the time of injury a distinction is to be made between (*a*) lesions sèches; (*b*) pulsating hæmatomas (or diffuse traumatic aneurisms); and at a later stage, (*c*) traumatic aneurism (circumscribed). In military surgery wounds which may involve large blood-vessels are explored as soon after injury as possible, because *débridement* is required to prevent infection, and because the patients must be transported and cannot remain constantly under surgical care. In civil life infection is little to be feared, and the patients do not have to be transported. In both civil and military surgery, however, the presence of a pulsating hæmatoma demands early operation. But a circumscribed traumatic aneurism should be left alone. Even where it is possible to do a Matas operation, it is desirable to leave it alone for several months, at the end of which time the walls lining the cavity will be in a condition where the operation can be done with comparative safety. If one does it too soon after the injury, there is nothing to hold the sutures. Whether the return of pulsation in the peripheral arteries that has taken place in Doctor Kelly's case is due to collateral circulation or to persistence of the lumen of the femoral artery, it is of course impossible to tell.

Dr. D. L. Despard said that he had a case of a man who was shot, the bullet passing between the artery and vein, cutting both. He immediately had tremendous swelling and cutting off of the circulation below. Operation seemed to be at once imperative; the wound in the artery was found and

closed; the vein he had to tie; pulse returned and was present for a larger part of the next day. It was very faint, however, and the evening of the second day after operation it could not be felt at all. It returned in three or four days, evidently reëstablished through collateral circulation. The man had complete recovery of circulation in the leg.

Dr. Hubley R. Owen showed again a case which he reported to the Academy some time ago of gunshot wound of the popliteal artery. At the time he reported it as a popliteal aneurism.

Since then he had operated on the man and found no aneurism but an aneurismal varix. There was a small opening between the artery and the vein, so small that he did not have to suture. He put in ligatures and the man made a good recovery. He had some swelling of the lower leg and had to wear a canvas stocking. Two or three weeks later he did a second operation and made a search for the small piece of bullet, but it could not be found. His Wassermann was negative.

GUNSHOT FRACTURE OF THE FEMUR AND WOUNDS OF THE FEMORAL VESSELS REQUIRING AMPUTATION

Dr. Damon B. Pfeiffer presented a negro man, aged twenty-nine, who was admitted to the Presbyterian Hospital at 10.30 p.m., December 25, 1922, on the service of Dr. John H. Jopson. About an hour previously he had been shot with a .38 calibre automatic pistol loaded with steel-jacketed bullets. He was hit twice, the first bullet causing a tangential wound of the anterior abdominal wall. The wound of entrance was in the right rectus just below the costal margin and the wound of exit over the left rectus at a point symmetrically situated. A transverse ridge, indicating the course of the bullet could be seen and felt between the two except where the tract had passed through the muscles. Examination showed no abnormality of the abdomen; he was not shocked; he presented no sign of loss of blood. Temperature was 99; pulse, 80; and respirations, 20 per minute. He complained of some dull pain in the right thigh, but on the whole was fairly comfortable and in good condition. The right thigh was enormously swollen throughout and the tissues were tense and hard. The thigh was warm but below the knee the leg was cold and no pulsation could be detected in the anterior or posterior tibial arteries. Sensation in the leg was present but diminished. There was a bullet wound of entrance on the outer aspect of the thigh at the junction of the middle and lower third. At this point the thigh was fractured. It was evident that a wound of large vessels was present and the situation made it probable that the femoral vessels were concerned. No thrill or bruit was present.

Doctor Pfeiffer, realizing that the condition probably called for amputation, decided, however, on account of the excellent condition of the patient, to determine whether a reconstructive operation could be done. He accordingly debrided the wound of entrance down to the site of fracture. As soon as the fascia lata was incised the muscle herniated through the wound under great internal pressure. The femur was extensively comminuted. The tissues in immediate relation were pulpi-

fied, and a large cavity was present filled with blood-clot, detached splinters of bone, and surrounded by infiltrated connective tissue and muscle. At the upper limit of this cavity the femoral artery could be felt pulsating. Below this point no pulsation could be detected. Release of tension and disturbance of the cavity resulted in active hemorrhage. The tourniquet which had been placed about the thigh was therefore tightened and an incision made on the inner aspect of the thigh to afford better access to the vessels. So great was the infiltration of the tissues that difficulty was experienced in locating the vessels and it was noted at about this time that the patient was showing signs of shock which made it doubtful whether he could endure any unnecessary prolongation in the operation. He therefore decided to amputate without delay. The lead core of the bullet was found in the large cavity and the steel jacket which had bcome detached lay beneath the skin on the inner side of the leg.

After an intravenous infusion of salt solution the man rallied well and made an uncomplicated recovery, excepting for a slight stitch infection of the uppermost sutures, which fortunately did not become communicated to the field of amputation. The vessels were later dissected and it was found that both the femoral artery and vein had been almost completely divided, being held together by only a narrow bridge of the posterior portion of the vessel walls. In addition there was a punctured wound of the femoral artery about one inch distal to the large wound. The reporter remarked that although vascular surgery has now reached the point where it is indicated to consider repair rather than ligation or amputation as primary procedures, this case violated all the conservative rules laid down by Makins for the performance of suture. There was no reasonable probability of maintaining the wound in an aseptic condition. The wounds of the vessels were multiple and extensive. Circular suture would have been required and immobilization in a position to secure freedom from tension was impossible because of the fracture.

Concerning the necessity for amputation it should be realized that ligation of the femoral vessels at the point of origin of the anastomotica magna would be likely under any circumstances to be followed by gangrene or such damage to the leg that its usefulness would be abolished. The added danger introduced by the comminuted fracture made the risk to life prohibitive. Preliminary exploration, however, was indicated by the fact that wounds of the branches of the femoral artery may at times cause a hæmatoma of great dimensions simulating a wound of the parent vessel. In such a case simple ligation would probably save the leg.

REPAIR OF THE MUSCULO-SPIRAL NERVE

Dr. D. L. Despard presented a boy, aged thirteen years, who was admitted to Abington Memorial Hospital, May 11, 1919, having been injured by receiving a load from a gun at 12 or 15 feet distant. The outer and posterior part of the triceps was carried away and with it the musculo-spiral nerve for about four inches. The skin wound was so extensive that efforts toward primary repair of the nerve were not wise.

On October 15, five months after the injury, the wound having completely healed, the ends of the nerve were exposed, and by stretching, the gap of four inches was reduced to two inches, the bulbous ends were freshened up and both ends sectioned half through about an inch and one-third from their extremities and split longitudinally to within a third of the ends, the flaps thus formed were approximated, bridging the gap. The exposed nerve was then snugly surrounded by a cuff of fascia lata from the thigh. The wound healed by first intention, and in about two months there was some evidence of the reëstablishment of function.

The progress was very slow for a while, and he lost sight of the patient until June of 1921, when he then saw him his recovery was very satisfactory.

His reason for reporting this case is that this method has not been of late years generally popular, and to show that in some cases it is justifiable, especially in the very young, where nerves available for bridging the gap are so small as not to be suitable.

Dr. De Witt Stetten (of New York) commented on the result obtained in this patient with musculo-spiral paralysis. He was especially interested in this case because he had done the same operation once himself and because the method is one that is universally condemned by neurological surgeons to-day. Eleven years ago he saw a case of complete musculo-spiral paralysis secondary to an operation for osteomyelitis of the humerus. The nerve had evidently been severely damaged during the bone operation because he found a dense scar in the nerve which he resected, leaving a defect of about an inch and a half. He then did exactly the same operation that Doctor Despard had performed, turning down the flaps from either end of the resected nerve to bridge the gap. A few days after the operation, in glancing through Sherren's book, "Injuries of Nerves and Their Treatment," he was much shocked to find that this method was described as one only to be condemned and that the results were as unfavorable as the method would lead us to expect. The author referred to other methods to be used in such cases and laid particular stress on the auto-transplantation of relatively silent sensory nerves—for example, the radial nerve from the forearm in musculo-spiral paralysis. He felt that he had made a very serious blunder and was more or less convinced of that fact after a year had passed without any return of function. But after fourteen to sixteen months, the patient began to show some restoration of muscular power in the extensors of the wrist and fingers and within the next four to six months he made a complete recovery. The method may be a bad one, but certainly it sometimes works rather well—even better than the recommended methods—as these cases have demonstrated.

Dr. Astley P. C. Ashhurst said that at the first joint meeting of the Academy with the New York Surgical Society (Annals of Surgery, 1920, vol. lxxii, p. 408) he reported three cases of nerve suture, two of the patients having been treated in this way with flaps turned down from the ulnar or

median nerves, with perfect recovery. The neurologists say recovery is not possible by this method and that the patients get regeneration of the nerve in spite of the operation. Perhaps they might claim that the nerve impulses in Doctor Despard's patient do not come through the collateral circulation, as it may be called, which was established by the operation; but that the nerve fibres have eventually perforated the bulbous scar and have found their way to the distal end of the nerve along the channel established by the tube of fascia lata. But in his own two cases, where the neuroplasty was a primary operation, for recent injury, no fascial tubes of any kind were placed around the nerves.

SPLENECTOMY FOR ADVANCED SPLENIC ANÆMIA

DOCTOR DESPARD recited the history of a boy, aged thirteen years, who was admitted to Methodist Hospital, March 13, 1922, with an enlarged abdomen and swollen legs.

His general health had been good until 1914, when he developed acute mastoiditis and was operated upon for it. He was reoperated upon November the same year for a recurrence of the trouble.

In the spring of 1916, he had pneumonia; following this he developed acute appendicitis, was operated upon, an abscess drained, and the discharge continued for four months. During this time he was said to have had an abscess of the liver. The stools contain pus.

Present Illness.—About six months after the appendiceal wound had healed, he felt badly, and it was noticed that the abdomen was swollen and he had lost a good deal of weight.

In the summer of 1920, after eating raspberries, he had an attack of acute indigestion and vomited blood and the abdomen was swollen at this time.

In 1921, he had a similar attack, and while he did not vomit blood, he passed it in the stools. The abdomen was swollen at this time, but this soon disappeared.

In December of 1921, he fell while playing and hurt himself, was nauseated and passed dark tarry stools. He has been losing weight, looked anæmic and felt badly since then. For the past three weeks he had been in bed. The abdomen is gradually getting larger, but he had not had tarry stools since being in bed.

Physical examination showed a very emaciated looking boy, slight œdema under eyes. Head, ears, eyes and teeth normal. Tonsils are not enlarged. The lungs and heart are normal. The abdomen is greatly distended with fluid, which embarrasses the respirations. Scar of previous operation below the umbilicus and to the right. The extremities are slightly œdematous and the reflexes are normal.

Clinical Notes.—Abdominal paracentesis March 16, 1922, and six quarts of turbid straw-colored fluid removed.

March 14, 1922, blood examination: hæmoglobin 60 per cent., red blood cells 3,040,000, white blood cells 3000, polymorphonuclear cells 50 per cent., small lymphocytes 30 per cent., large 20 per cent. Stools were negative for blood.

Chemical Examination of Blood.—Sugar, 0.1000 per cent.; urea, 18 mg. per 100 c.c.; creatinin, .9 mg. per 100 c.c.; chlorids, 6.25 mg. NaCl per L.; uric acid, 1.5 mg. per 100 c.c. Wassermann negative.

Examination.—Ascitic fluid March 16, 1922, color pale yellow, turbid, no coagulation, albumin 1.9 per cent. After paracentesis the spleen was found to be enlarged and to extend 6 or 7 cm. below the costal border.

April 4 paracentesis again performed, yielding 196 fluid ounces, temperature is ranging between normal and 100 degrees.

Blood Examination.—April 4, 1922, hæmoglobin 55 per cent., red blood cells 2,800,000, white blood cells 2400, polymorphonuclears 60 per cent., small lymphocytes 28 per cent., large lymphocytes 8 per cent., monomorphonuclears 4 per cent., coagulation time 3 minutes.

April 6, 1922.—Splenectomy through a left rectus incision. The spleen was very large, extending to the crest of the ilium. The number of adhesions to diaphragm were few and easily broken up; the liver was enlarged and relatively smooth. A large amount of milky fluid was liberated on making the incision.

Before closing the wound an extensive epiplopexy was done. The patient was somewhat shocked from the operation and an immediate transfusion of 500 c.c. of blood by direct method was performed. The wound healed by first intention, but notwithstanding this the temperature range was from 100 to 103 degrees, gradually subsiding, but in the neighborhood of 100 at the time of discharge from the hospital.

The blood examination nine days after the operation on April 15, 1922, was hæmoglobin 68 per cent., red blood cells 3,200,000, white blood cells 11,000.

A guinea pig killed one month after inoculation with ascitic fluid showed no evidence of tuberculosis.

Continued favorable reports of his progress have been received and he has gained weight, is going to school and seems to be well.

The reporter remarked that the reason for presenting this case was to call attention to the fact that in very serious cases of splenic anæmia, operation may under certain conditions bring about apparent cures.

The function of the spleen may be grouped under three heads: (*a*) Destruction of worn or feeble red cells, white blood cells and platelets. (*b*) The production of lymphocytes. (*c*) Filtering toxic substances and bacteria from the blood.

Normally the blood supply is vastly more than required for its own needs. Under the stimulation of toxins, possibly not always bacterial, this function becomes perverted, as evidenced by the wholesale destruction of red blood cells, the leucopænia, and the resultant injury to the liver in the production of a portal cirrhosis.

It would not seem illogical to assume that detrimental substances other than those that are known, might have their origin in an organ that had departed so far from the normal.

The removal of the spleen does good by diverting toxins from the blood,

or possible toxins originating in the spleen from the liver, which if continued, result in fibrosis of that organ and ultimate destruction of the liver cells.

It is for these reasons that the best results are obtained in the removal of large spleens that are sending immense quantities of blood to the liver laden with poisons, and the operation must be relatively early before irreparable injury has been done to the liver. It must be borne in mind that the liver has powers of regeneration, and may in time recover from considerable injury.

Small spleens are not so charged with possibilities for damage, and their removal is not accompanied with such marked improvement, even in hæmolytic jaundice.

The specimen removed is a spleen markedly enlarged, moderately soft and dark in color. On sectioning there is noted a considerable thickening of the capsule with much fibrosis throughout the entire organ. The pulp is soft and wet and much blood exudes from the cut surface. Weight is 1460 gms.

Sections show spleen in which there is considerable dilatation of the sinuses which are filled with blood. There is a distinct increase in connective tissue throughout the section. Some sclerosis of the splenic vessels is found and the capsule shows a marked thickening. The trabeculæ are also much increased in size. The gross and microscopic appearances of the spleen are consistent with those of an early Banti's disease.

TECHNIC OF INGUINAL HERNIOPLASTY

Dr. De Witt Stetten, of New York, read a paper with the above title, for which see page 48.

Dr. John H. Jopson said there are two or three fallacies in the general belief regarding hernia. A great many failures are due to the fact that the individual case has not been studied at the time of operation. The operation for hernia is a plastic one and there are varying conditions to be met just as in any other types of plastic operation. Failure is due to the fact that many surgeons simply go through the motions of the operation. He thought the Fergusson operation was a great step backwards in hernia work. Again, one can get muscle to adhere to fascia by suture, in spite of statements to the contrary. He knew that it will grow there because he recalled two cases where he operated for femoral hernia through the inguinal route, after an inguinal hernia operation had been performed, doing Ruggi's operation, and found the fibres of the internal oblique and transversalis so closely adherent to Poupart's ligament that one might have thought they had been implanted there originally instead of sutured by the surgeon.

Dr. Hubley R. Owen said that a couple of years ago he read a paper on hernioplasty before the State Medical Society; and, on looking up data for this paper, he found only two papers which gave statistics which were accurate. It was because these surgeons or some member of their staffs had personally examined the cases for recurrences.

Doctor Ashhurst in his surgery cited Coley's statistics and said recurrence occurred in very few cases. Blake quoted 25 per cent. recurrences. In the Mumford series of 97 there was one recurrence. Da Costa quoted Coley's figures. Rosenthal quoted 10 per cent. Masson, of the Mayo Clinic, out of 17,017 cases in a series, less than one per cent. recurrences. There are few statistics which differentiate the direct from the indirect, and statistics without this differentiation are of little value. Taylor of the John Hopkins reported a series of 230 cases for indirect with 46 recurrences or 5.6 per cent. and 256 indirect with 18.08 per cent. recurrences.

Bruner reports 21.4 per cent. recurrences and Moscovitz 6.86 recurrences. Earle operated on 38 cases with no recurrences.

Unless a man examined his own cases at regular intervals of six months to two years he can't give accurate statistics. Taylor reported that of his cases examined at the hospital, there was recurrence in 29.7 per cent. and of those heard from by letter 6.3 had recurrences.

The speaker had performed Doctor Stetten's operation on 28 cases. Among these he had had but one recurrence. This recurrence was in a patient fifty-one years of age, operated on for bilateral hernia. There was a recurrence on the left side before he left the hospital. He could not definitely claim, however, that the other 27 cases had been cured, because some of these cases were but recently operated upon. None of them have been operated upon for a length of time to consider the cure absolute.

There was an excellent article in a recent ANNALS OF SURGERY by Erdman, giving the statistics of hernia on Pool's service. The great value of these statistics was that every case was examined by Doctor Pool or by a member of his staff. Of Erdman's cases there were 664 oblique hernias with 3.15 per cent. recurrence and 313 direct hernias with 16.61 per cent. recurrence. There were 255 indirect hernias with 17 per cent. recurrence.

From his own experience he believed that Doctor Stetten's operation has been more satisfactory than any other operation for direct hernia. Doctor Stetten discussed the question of age in so far as recurrence is concerned, Doctor Taylor of Johns Hopkins reports that 50 per cent. of the hernias recur after forty years and 25 per cent. after fifty years of age. Doctor Stetten does not agree with Doctor Pool that the operation is inadvisable after fifty-five years of age. The speaker agrees with Doctor Pool, if he finds a patient of even fifty years of age can wear a truss and the truss holds his hernia satisfactorily, he advises him to wear a truss, providing that the wearing of a truss does not interfere with his work. If he elects to be operated upon, he operates upon him, but tells him frankly the statistics regarding recurrence. The oldest case of his series was a man seventy-one years of age with a bilateral hernia. His hernia on the right side was of the type which is claimed to have "lost the right of domicile." He was unable to purchase a satisfactory truss. He has had no recurrence as yet, but the operation was only performed six months ago. Statistics are of no value until two years after an operation for hernia.

He did not think that Doctor Stetten's operation to be necessary in all cases. We should be guided by the type of case. An indirect hernia, especially in a child, requires only the ordinary Fergusson operation. The Stetten operation is advisable for a direct hernia and one where the muscles are weak.

As to anæsthesia he had not been able to get good results with local anæsthesia. The Johns Hopkins statistics show a larger percentage of recurrences in cases done under novocaines than those under general anæsthesia. He uses nitrous oxide gas, often infiltrating the line of incision with a little gas, and when he cannot do that he gives spinal anæsthesia.

Concerning the time in bed, he tries to keep all his cases in bed for two weeks, and direct hernias for 21 days. In the police and fire departments the men are not allowed to assume duties of any kind until four weeks after discharge from the hospital after a hernia operation and no active duty until three months after discharge from hospital.

Dr. Astley P. C. Ashhurst said that he did not know what his own results were, but he believed the statement quoted in his text-book from Coley's statistics to be correct concerning recurrences, and that after a properly done Bassini operation, 95 per cent. of indirect hernias do not recur. In the other figures quoted just now by Doctor Owen, the recurrences were approximately five per cent. after the Bassini operation where special attention has been paid to high suture of the neck of the sac. In direct hernias every one knows there is a much greater proportion of recurrences. The conjoined tendon is never absent. It may be defective but it is never deficient: there is always some place where the lower fibres of the internal oblique and transversalis muscles are inserted, and that is the conjoined tendon.

Dr. De Witt Stetten (in closing discussion on his paper): In regard to Doctor Owen's remarks he could not quite agree with him on the age question. A man fifty-five or even older, who is troubled by a hernia is as much entitled to relief as one of thirty-five. This is especially true when the operation is done under local anæsthesia and the risks of general anæsthesia are eliminated. Although it is a fact that the two recurrences he had observed were in men of fifty-five and fifty-six years of age, respectively, in general, his results certainly do not seem to indicate an unusual tendency to recurrence in older individuals. In his last series there are from twenty to thirty cases in men of fifty or over who seem cured, and he had made it a rule to examine these patients about once a month. This last group is composed mostly of private patients over whom he had relatively good control, and while not all have appeared as ordered, the large majority have reported regularly. To be sure, as Doctor Ashhurst has indicated, it is a bit too early to pass judgment in some of the cases. One should wait at least two years after operation before being certain of a non-recurrence.

Doctor Owen has pointed out that this particular technic is more complicated than the old Bassini operation and has suggested that it is not absolutely necessary in every case. He is quite correct. In a child, say of ten years

of age, suffering from a simple congenital hernia, with a small, thin sac and a ring the width of a lead pencil, the usual Bassini operation is almost certain to effect a permanent cure and this more elaborate operation may be dispensed with. He had been using this technic in practically all cases for purposes of practice and study, but its main indication is in old, large herniæ, especially in the direct variety and in recurrences, particularly in the types that were formerly considered incurable without some form of rectus muscle, anterior rectus sheath or free fascia transplantation.

With the rarest of exceptions, he had had splendid success with local anæsthesia. In this last series there was only one case in which he was forced to switch to general anæsthesia because the patient was so neurotic. He was so unreasonable that he began to cry out at the first needle prick and he really should never have tried to continue with local anæsthesia. Formerly he frequently took out the appendix in a right-sided hernia under local, infiltrating the mesenteriolum before ligating. He had found, however, that the search for the appendix and the drag on the mesentery during its delivery gives the patient an uncomfortable colic and now, when he does an appendectomy, he gives the patient a few whiffs of nitrous oxide while locating and removing the appendix.

He had found that, just in those cases where the conjoined tendon is defective, the overlapping of the external oblique aponeurosis beneath the cord compensates for that lack of development. In fact, it was to take care of this type of case that the idea originated. In these cases the external oblique aponeurosis is often well developed, sometimes actually hypertrophic, and the suture of the conjoined tendon to Poupart's could really be disregarded altogether.

He agreed with Doctor Jopson concerning the many current fallacies in views on hernia and he seconded his opinion as to the Fergusson type of operation without cord transplantation, especially as regards direct hernia. If it is admitted that non-transplantation of the cord is wrong in principle and favors recurrence in practice, then the maximum transplantation possible, as in the technic advocated, should be right and should offer the best chance of a permanent cure. Another fallacy that has persisted is the idea that covering the cord with the external oblique aponeurosis, allowing the cord to emerge obliquely, is necessary as a part of the hernial repair. Now when this is done and a recurrence develops, the new sac protrudes under the aponurosis, indirectly through the old internal ring, or directly, medial to the epigastric vessels, irrespective of and in no way influenced by the aponeurotic covering over the cord. His plan is therefore to use everything available to strengthen the weak spot, which is all medial to the point of exit of the cord, whether the hernia be direct or indirect. It is of much more important to hug the cord, at its exit, as closely as one can with safety than to have it emerge obliquely. If there is a more or less straight emergence of the cord, without kinking or angulation, the snuggest possible suture of the ring may be made with the least chance of interfering with the testicular circulation.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting Held March 14, 1923

The President, Dr. John A. Hartwell, in the Chair

INOPERABLE MELANOTIC SARCOMA OF THE NECK; ENTIRE DISAPPEARANCE UNDER ACCIDENTAL STREPTOCOCCIC INFECTION

Dr. William B. Coley presented a girl about ten years of age, whom he said he had previously shown before the New York Surgical Society, in 1918, at which time she had remained well for three years; but the later developments had added increased interest to the case, making it worthy, in his opinion, of a second presentation. Doctor Coley, in briefly reviewing the case (history published in full in the Annals of Surgery, 1918), said that an exploratory operation had been performed in July, 1915, and a diagnosis of melanotic sarcoma was made by Dr. S. B. Moon, Pathologist of the Medical College of Virginia. This diagnosis had been confirmed by Doctor Ewing. The tumor steadily increased in size until December, 1915; the patient was becoming markedly emaciated, and her condition was regarded as absolutely hopeless. At this time she had an accidental streptococcic infection, with a temperature of 106; the tumor partially broke down, the remainder disappeared by absorption, and she remained in perfect health until the spring of 1920. At this time she developed a rapidly growing tumor in the right upper cervical region, involving the parotid. Doctor Coley's clinical diagnosis was round-celled sarcoma. The tumor was soft in consistence; no infiltration, and no discoloration. A portion of the tumor was removed for microscopical examination (Fig. 1) and pronounced round-celled sarcoma by Doctor Jeffries, pathologist of the Hospital for Ruptured and Crippled; diagnosis confirmed by Doctor Ewing. One radium-treatment, lead tray, was applied and the patient was put upon systemic doses of the mixed toxins of erysipelas and bacillus prodigiosus, which treatment was kept up for about four months. The tumor entirely disappeared in about four weeks, and the patient has remained in perfect health up to the present time, nearly three years later.

In his previous report, Doctor Coley called attention to the fact that in Escher's 68 collected cases of malignant tumors in which an accidental or artificially produced attack of erysipelas infection had taken place, great improvement in the local and general condition of the patient was noticed in the majority of the cases. In ten of twenty-seven cases of sarcoma, the tumor entirely disappeared, and nine were apparently cured. One of these cases was a melanotic sarcoma. Doctor

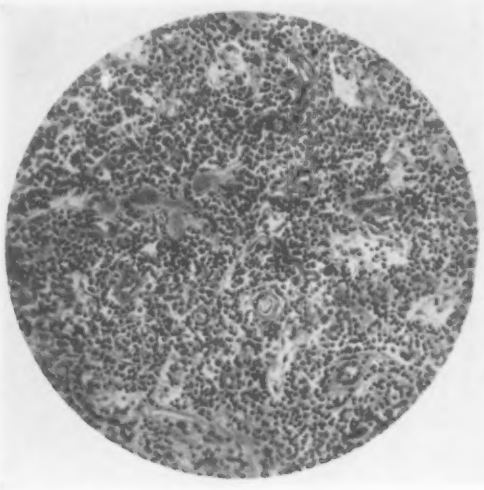

FIG. 1.—Round-celled sarcoma.

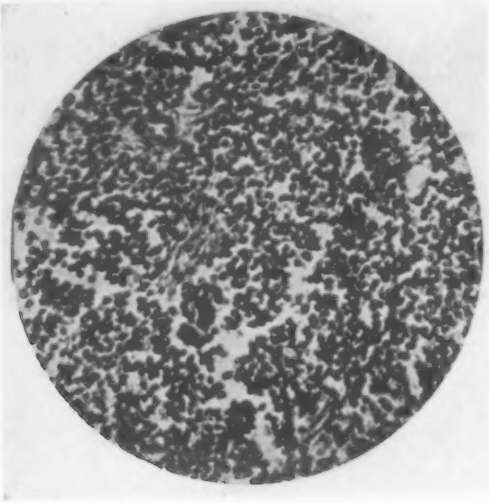

FIG. 2.—Endothelioma (round-celled sarcoma).

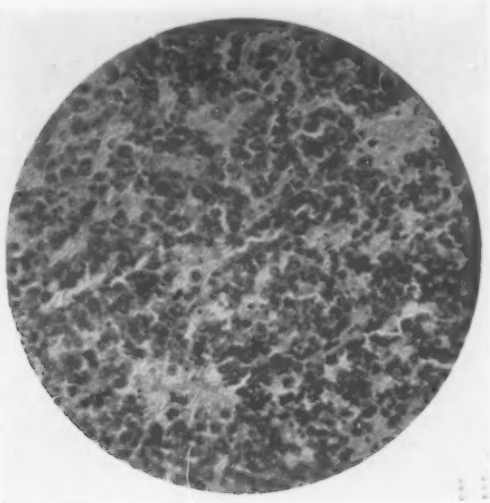

FIG. 3.—Endothelioma (round-celled sarcoma).

Coley added, that as far as he knew, this was the second case of melanotic tumor cured by accidental erysipelas or streptococcus infection, although several cases of inoperable melanotic sarcoma have been apparently cured by the mixed toxins, and well more than eight years.

PERIOSTEAL SARCOMA OF FIBULA

DOCTOR COLEY presented a case of periosteal sarcoma of the fibula with extensive metastases in the inguinal, femoral, and iliac glands, and in the lung; amputation; toxins and radium treatment; patient in good health two years and nine months after amputation.

The patient was a lad fifteen years old, who was admitted to the Hospital for Ruptured and Crippled in May, 1920. Family history negative. In January, 1920, the patient received a blow on the outer side of the right leg, followed shortly afterwards by pain. A few days later a swelling developed, apparently of bony origin, which increased in size until the end of March, 1920, when an operation was performed by Dr. Armitage Whitman at the Hospital for Ruptured and Crippled. Clinical and X-ray diagnosis: osteomyelitis; microscopical diagnosis: periosteal sarcoma. The tumor increased in size even more rapidly after the operation, and when seen by Doctor Coley in consultation, in June, 1920, the lower two-thirds of the fibula was occupied by a large tumor, apparently of periosteal origin, fungating in the central portion, at the site of the recent curetting. The glands in the groin were markedly enlarged. In view of the large size and rapid growth of the tumor, it was thought unwise to try any method of conservative treatment; immediate amputation was advised and performed by Dr. Armitage Whitman. Microscopical examination, round-celled sarcoma, periosteal. This diagnosis was confirmed by Doctor Ewing. The patient was then referred to Doctor Coley's service for toxin treatment, which was immediately begun and pushed to the point of producing marked reactions. This treatment was continued until the middle of August when, on account of the excessive heat, the patient was permitted to go to the country. One of the glands in the groin was removed in July, and pronounced sarcoma. Examination on his return to the hospital, October 23, 1920, showed that the glands in the groin had increased in size; there was a mass in the right iliac fossa, about the size of a child's head, apparently involving the retroperitoneal glands; and an X-ray picture of the chest showed well-developed, unquestionable metastasis of the lung. The patient was admitted to the Memorial Hospital on October 27, 1920, and received 10,109 mc. hours of radium over the right iliac region at a distance of 6 cm. An entirely hopeless prognosis was given to the family, who refused to have further treatment carried out, and the patient returned home. In May, 1921, I received word from his parents that the boy was attending school, and was in excellent health. In September, 1921, nearly a year after the last treatment, examination showed no evidence of any tumor in the abdomen or groin; and an X-ray picture of the chest showed the lungs to be normal. The patient was shown before the Memorial Hospital conference on December 23, 1922, in perfect health, and the latest

X-ray picture taken in March, 1923, two and one-half years after metastasis had been observed, showed not the slightest suspicion of trouble in the lungs. The microscopical section of the original tumor (Fig. 2) was later reviewed by Doctor Ewing, who classed this case in the group of endotheliomas; hitherto, these tumors were classed as round-celled sarcoma and are still so classed by most pathologists. An interesting point about them is that they are more malignant than the ordinary periosteal sarcoma and are more prone to metastasize. Sufficient time has not elapsed to classify the present case as a cure; nevertheless it is of extreme interest, as it is one of the very few cases of periosteal sarcoma with metastases in the lungs that has remained well for any considerable period of time.

Doctor Coley presented a case of periosteal sarcoma of the upper half of the femur, with pathologic fracture, and probable metastasis of the spine; recovery under toxins and radium; well at present one year and eight months.

The patient was a woman, forty-four years old, who was admitted to the Memorial Hospital in July, 1921, with the following history: In the fall of 1919, while adjusting a window shade, she fell, striking her hip on the sharp edge of a piece of furniture. In the winter of 1920, she noticed numbness in both feet and began to limp, being obliged to use a cane; was treated for rheumatism. The condition gradually grew worse during the winter and in January, 1921, she was treated for a short period at the Neurological Institute. She was later admitted to the New York Hospital for Deformities and Joint Diseases, where an X-ray picture was taken and a diagnosis of tumor of the femur was made. In February, 1921, she was examined at the Memorial Hospital; and an X-ray picture was taken by Doctor Quick, who regarded the condition as hopeless; no treatment was advised. In March, 1921, she entered Mt. Sinai Hospital and was placed under the care of Dr. Howard Lilienthal and Dr. H. Neuhof. By this time, a pathologic fracture had occurred. An exploratory operation was performed in the latter part of March, revealing a large tumor, which involved the upper third of the femur. A portion was removed for microscopical examination and the diagnosis of perithelioma was made by Doctor Mandlebaum; after further study, his final diagnosis was: "Plasma cytoma—a malignant tumor originating in bone-marrow and chiefly made up of plasma cells." Complete loss of power developed in the left leg and partial loss in the right, pointing to probable involvement of the spine. The condition was therefore regarded as absolutely hopeless and the patient was referred to the House of Calvary, a home for incurable cancer cases. In the early part of July, the patient's husband was referred to Doctor Coley by Dr. Robert T. Morris, and consulted him in the hope that something might be accomplished by the toxins treatment. After obtaining a careful history of the case from Doctor Quick and Doctor Lilienthal, Doctor Coley gave an absolutely hopeless prognosis and declined to see the patient. The husband returned on the following day to Doctor Coley, who finally consented

to examine the patient. She was brought to the hospital in an ambulance. Physical examination showed a tumor involving the upper half of the left femur; the patient was greatly emaciated, and was unable to move the left leg; only slight motion in the right leg. The tumor evidently was of bony origin. There was a pathologic fracture at the middle and upper third of the femur. X-ray picture taken showed involvement of the upper third of the femur for about seven inches, with a pathologic fracture in the centre. On account of the large destruction of bone, it was impossible to say definitely whether the tumor was of central or periosteal origin. Buck's extension was applied. Doctor Coley still regarded the condition as apparently hopeless and doubted very much if any temporary improvement worth while could be obtained from the treatment. The toxins were given in gradually increasing doses up to the point of producing marked reactions, temperature of 103–104, and continued up until the middle of September, 1921. At the end of two weeks, marked improvement in general health was noticed; and an X-ray picture taken at the end of the month showed local improvement in the tumor; no further extension of the disease, and beginning regeneration of bone. In the middle of September, 1921, one radium pack treatment was given (10,000 mc. hours at 6 cm. distance); and the toxins were continued. Buck's extension was removed in October, 1921, and in December a Thomas splint was applied. The patient was then able to get about in a wheel chair, and had gained twenty pounds in weight. By January, 1922, she was gradually regaining power in her limbs, and a plastic operation was performed to lengthen the tendon Achilles which had been greatly contracted during the long period in bed.

The patient has had no further toxin or radium treatment since January, 1922. She is now in excellent general condition. While she still uses crutches, she can walk without support. X-ray shows firm union of the bone and no evidence of a recurrence of the disease. X-ray picture of the chest fails to reveal any evidence of metastases. Doctor Ewing made a careful study of the microscopic section.

According to Doctor Ewing's classification, this case should be placed in the same group of endothelial myelomata, or endotheliomas, as the preceding case (Fig. 3).

PERIOSTEAL SARCOMA OF FEMUR

Doctor Coley then showed a patient whom he had presented to the New York Surgical Society about two years before, with a history of a very large, inoperable, periosteal sarcoma of the upper two-thirds of the femur, following a recent fracture; pathologic fracture; complete destruction of five inches of bone; disappearance of tumor under combined toxin and radium treatment; reunion of bone. Patient well, with a useful limb, five and one-half years later.

A full history of this case, with photographs, will be found in the Transactions of the American Surgical Association, 1919.

Doctor Coley showed an X-ray picture of the femur before treatment had been started, which had not been previously shown nor in-

cluded in any of the published articles. He also presented a lantern slide of a recent picture showing firm union of bone. The patient is now in perfect health, working in the Singer Sewing Machine Factory, and gets about without any support.

Doctor Coley said that this case had been regarded as absolutely hopeless by every member of the Memorial Hospital conference; that while no microscopical section had been made of the tumor, the history of rapid growth, enormous size, and typical clinical picture, left no ground for doubt as to the correctness of the diagnosis.

Dr. Theodore Dunham said that apropos of these cases of Doctor Coley's, he was reminded of two cases which had been in his care about thirty years ago, one in which an erysipelatous infection had cured the patient and another which he had treated with Doctor Coley's erysipelas and prodigiosus toxins. The first case came under his care while he was assistant to Doctor Abbe, a child about two years old having an enormous tumor inside the cranium, bulging out the right eye from its socket and involving the temporo-frontal region so that the skull was absorbed and a softly fluctuating tumor presented. An exploratory operation was done, a piece of the tumor was cut out, it was examined and was pronounced to be endothelioma. The case was considered hopeless. He asked Doctor Abbe to allow him to treat the patient with Doctor Coley's toxins, and did so for six or eight weeks, giving what doses could be tolerated. During that time the tumor did not make any progress, whereas up to then it had been rapidly progressive, but seemed to become smaller. The child was sent home for a period of a few weeks, after which it was brought back for another course of treatment lasting a number of weeks, and the child then went home for good. Doctor Dunham saw the patient eight or ten years afterward and, though there was still some bulging, the growth had come to an entire standstill. The other case, although not a case of malignant disease, was interesting in this connection in that it presented an instance of a growth of abnormal tissue which was selected for destruction by an attack of erysipelas. The patient presented a large angioma on the abdomen, such as is found at birth. Doctor Dunham planned to remove the tumor by operation, but before the operation could be performed the patient came down with an erysipelas, which included the whole abdomen, and the child was very sick, with a high fever. The tumor shared in the erysipelatous infection, became necrotic and sloughed away, leaving a clean, crisply outlined, granulating crater. The tumor had been destroyed by the erysipelatous infection, while the surrounding normal tissues fully recovered. Here was a clearly selective action of the infection upon the tumor. These cases occurred before the discovery of either radium or the X-ray.

Dr. Edwin Beer, referring to the radiogram of the periosteal sarcoma of the femur in the third case, recently taken out of town, in which the shaft of the femur is shown broken close to the trochanter, said that he had noticed

that at the lower end near the centre of the femur there is an area which looks like ostitis cystita fibrosa, and it raised the question in his mind, was the first lesion of this nature?

Dr. Royal Whitman, referring to the radiogram of the fourth case presented, said that if Doctor Coley had known the tumor was to disappear, he doubtless would have placed the shaft in extreme abduction to correspond to the position of the upper fragments. The angulation at this point and the persistent adduction of the limb accounts for much of the shortening and disability.

Dr. John A. Hartwell expressed his belief that the problem of the value of the treatment described by Doctor Coley will ultimately have to be settled by the morphologists, the men who are studying the histology of tumor conditions. Doctor Coley reported that the diagnosis of the type of tumor he was dealing with, has been changed in one or two instances of the cases shown. These cases have many characteristics of malignancy. As he recalled Doctor Coley's previous reports good results may be obtained in about 10 per cent. of the cases treated while the remaining 90 per cent. are uninfluenced. It hardly seems probable that the same tumor is influenced in such a variable way by the same means of treatment, and it must therefore be that while our present knowledge does not permit us to properly classify these tumors, there is an essential difference in their biology. If they are all of the same type there is no explanation for some of them responding so successfully while others are so resistant to his treatment. It would seem that the true answer as to its value cannot be given, until there is a further differentiation possible which will separate these tumors more specifically, and it may be that therapeutic response will be the means of finally accomplishing this differentiation.

Doctor Coley, in closing the discussion, first took up the point that had been raised by Doctor Hartwell. He said that anyone who had made an extensive study of sarcoma of the long bones knew that it was impossible to place them all in a single class or group; but that they should be divided into a number of fairly well-defined groups. For example, the group of central endosteal tumors made up chiefly of the giant-celled type; if seen in an early stage most of them were benign, in this sense they did not metastasize; many of these may be cured by simple curetting and carbolic acid. In some of the cases of this group, especially those in the more advanced stage, the diagnosis is extremely difficult; for in addition to the giant cells, there are often present a considerable number of spindle cells, and it may be impossible for the most expert pathologist to definitely determine whether a case is malignant or benign. Several of these cases, in Doctor Coley's experience, have ended in death from metastases. While amputation has been the rule in this group of central sarcomas, in most cases it has been found possible to save the limb by conservative methods: toxins, or radium, singly, or combined, with or without curetting.

There is another group, however, of the so-called sclerosing type, with a large amount of very dense new bone formation. In this type, Doctor

Coley stated, he had never seen a case saved by conservative treatment; neither toxins nor radium had any marked effect on the tumor, and only amputation followed by prophylactic toxin treatment gave any hope of saving the patient's life. In such cases, amputation should be performed early and in no way delayed by any trial of conservative methods.

There is still another group of cases, which hitherto had been called round-celled sarcoma, but which now is classified by Doctor Ewing as endothelioma or endothelial myeloma. This group, clinically, can be fairly definitely differentiated from the other types of bone sarcoma. It is usually characterized by extensive thickening of the shaft and involvement of the shaft rather than the extremities. There is very little new bone formation, as shown by the X-ray pictures. Marked destruction of the bone, followed by pathologic fracture, is not infrequently observed; and this type of tumor is especially prone to metastasize in other bones as well as in the lungs. Howard and Crile, in 1905, were the first to make a study of this type of tumor, endothelioma of the bone; and they published a series of 23 cases, 19 collected from the literature and 4 personally observed. The most interesting point brought out by their study is, that this type of tumor is the most malignant of all types of bone sarcoma, only one of the twenty-three cases having recovered from high amputation and well for three years. Another interesting point is, that this type is more prone to metastasize than any other type of bone sarcoma, metastases having been noted in sixty-six per cent. of Howard and Crile's cases. Doctor Coley stated that metastases had been noted in nearly all of the cases observed at the Memorial Hospital.

As to the question raised by Doctor Beer as to the possibility of the diagnosis in the third case presented this evening being osteomyelitis. To this Doctor Coley replied that, clinically, this tumor had all the aspects of a malignant tumor: it had developed—as is so often the case—shortly after a fall; it had steadily increased in size until it had finally produced a pathologic fracture, with probable metastases in the bones of the pelvis or lower spine. The patient at no time had had any temperature nor was there any other evidence of an inflammatory condition. Macroscopically, on exploratory operation, it showed every evidence of being sarcoma; and all of the pathologists who had examined it, including Doctors Mandlebaum, Ewing, Wolbach, Mallory, and MacCarty, were unanimous in the opinion that it was a malignant tumor.

As to Doctor Whitman's suggestion that in Case IV, in which there was five inches shortening of the femur, the leg should have been put up in abduction: Doctor Coley replied that it was kept in the Buck's extension most of the time while the patient was in the hospital; that very little attention was paid to placing the leg in perfect anatomical position, for the reason that no one believed there was one chance in a thousand of saving the patient's life. It was regarded as such a hopeless case, that Doctor Coley was criticised for having the patient occupy a hospital bed for eight months.

To Doctor Dunham's question, as to whether radium was always used with the toxins, Doctor Coley replied that, during the past seven years at the

Memorial Hospital, they had been trying several methods of treatment of long-bone sarcoma, using radium alone for one group, toxins alone for another, radium and toxins combined for another, and radium and X-ray for another. The results in this series of cases will shortly be published. So far, the only cases of long-bone sarcoma that have recovered under radium alone, or X-ray alone, and have remained well for over three years, have been of the central giant-celled type. Better results have been obtained with a combination of the local effect of radium and the systemic effect of the mixed toxins, than by the use of either agent alone.

MULTIPLE HERNIÆ, INGUINAL, FEMORAL, EPIGASTRIC

DOCTOR COLEY showed a recent case that had been operated upon eight weeks ago for inguinal, femoral and epigastric hernia. He said that while it was not infrequent to find several varieties of hernia in the same individual, in his thirty-three years' experience at the Hospital for Ruptured and Crippled, he had never before seen this particular combination. In 9750 operations for hernia at that hospital, only twenty cases of epigastric hernia have been observed.

FRACTURES OF THE FEMUR IN CHILDREN

DR. CARL G. BURDICK presented nine children illustrating the paper of the evening. For this paper, see vol. lxxvii, p. 736.

DR. EDWARD D. TRUESDELL called attention to the making up of shortening following fractures of the femur in children and in the consequent elongation of the extremity that was not uncommonly observed. Two years ago he had presented before the society, five children having inequalities of the lower extremities following fractures of the shaft of the femur. These fractures had varied in situation and variety. They had been variously treated, by simple end-to-end reduction; by the Steinman pin; the tongs; or the Lane plate. Four had shown some degree of shortening at the termination of treatment. All had finally presented some degree of elongation, this varying from one-half inch to even an inch.

A year ago the speaker had read before the society a paper on fractures of the femur in children, representing that part of an investigation of all fractures treated at the St. Mary's Hospital for Children during a period of five years. There had been 40 fractures of the femur and 27 of these had been seen and examined, periods of from six months to more than four years having elapsed since the injury. Of 11 cases that had been shown, some degree of shortening at the termination of treatment, 5 had returned to equality, and 6 had proceeded to elongation, more or less marked. Six cases had presented no primary or late inequality. Three cases had shown an inch of shortening at the termination of treatment and all three had almost completely compensated for the disparity. Thus in 14 of 27 cases investigated the stimulation of bone growth was clearly manifest, while in only one case was there no tendency to compensate for shortening, and this had been the only case in the series that had shown disinclination to callus formation and normal bone repair.

The speaker believed that moderate degrees of shortening at the termination of treatment were not unfavorable but that primary angular deformities should be corrected if possible, since these were the source of the usual permanent distortions of the bone. The pin or calipers were very useful to prevent excessive over-riding, rather than to eliminate lesser degrees of shortening.

In his experience marked degrees of inequality of the lower extremities following fractures of the shaft of the femur in children were not due to persistent shortening because of uncorrected over-riding of the fragments, but were due to elongation of the injured limb. Inequality due to lengthening has been found at times to be the cause of obvious tilting of the pelvis with compensating curvature of the spine.

Apparently a brief period of stimulation of bone growth very commonly accompanies injuries to the femur in children, and where this is excessive and is a source of inequality this inequality is permanent, since it has been found to exist ten years after the injury.

The speaker also corroborated Doctor Burdick's observation that firm union was regularly obtained in those cases where only cortical apposition of fragments existed provided that ample time was afforded.

Dr. Frank S. Mathews referred to a recent case of fracture of the femur in a child which he had seen some time after the receipt of the injury, when the over-riding was considerable. Some persons interested in the case had urged open operation; at that time he had asked a number of surgeons whether they had ever seen an adult with a persistent limp as a result of a simple fracture of the shaft of the femur in childhood. He had been unable to learn of a single case of the sort. His experience led him to concur in the methods of treatment advocated by the writer of the paper, and in complicated cases he used skeletal traction to the almost complete exclusion of open operation and plating.

Stated Meeting Held March 28, 1923

The President, Dr. John A. Hartwell, in the Chair

MYXOSARCOMA OF THIGH INVOLVING THE FEMORAL VESSELS

Dr. Harold Neuhof presented a man, thirty years old, who had been admitted to hospital on account of a progressively increasing swelling in posterior aspect of left thigh, of one year's duration.

Upon examination there was a large tumor mass occupying the lower half of the thigh down to the popliteal region. It measured 7 by 6 inches. It was of semi-solid consistency and appeared closely related, but not attached, to the femur. There was no evidence of interference with the circulation other than dilated veins in the skin over the tumor. Upon exploration with the needle blood was obtained. A specimen was removed in which it was difficult to differentiate between myxoma and myxosarcoma.

At operation, July 22, 1922, a free incision was made, and the sciatic nerve was found spread out and flattened over the superficial surface of the tumor. The latter had a well-defined capsule on the surface, but this was lost in the depths. The neoplasm was lodged between the inner and outer hamstring muscles, displacing them. On the superficial surface and to a more marked extent than the deep surface there were a number of greatly dilated veins. The sciatic nerve was dissected free, the veins running into the capsule tied off, and the neoplasm dissected free to the region of the femoral vessels. The latter were isolated above and below the neoplasm but were definitely incorporated in part in the growth. The femoral vein was found intimately fused with the tumor for a distance of 6 cm. Here its wall was white, thickened and firm in consistency, the lumen being evidently occupied by solid material. In this region the arterial wall was also attached to the neoplasm for about 2 cm. The femoral vein was resected beyond the involved portion. Serrefines were then applied to the femoral artery above and below, and the wall of the latter where it was involved by the neoplasm was resected for a length of 2.5 cm. The lumen of the artery was found to be free. It was irrigated with 3 per cent. sodium citrate solution and subsequently with normal salt solution. Suture of the oval arterial defect was made with Carrel silk and fine needles. The suture was continuous, approximating intima to intima, and resulted in the reduction of the diameter of the artery by one-half. Upon removal of the arterial clamps there was oozing at several places requiring reinforcing suture. Through pulsation of the artery was noted. Soft parts and skin were closed in the usual manner.

It is now nine months since the operation. Patient has remained free from recurrence. There is normal function in the extremity except for slight limitation of flexion at the knee. The dorsalis pedis and posterior tibial arteries at the ankle, in which pulsation was present directly after the operation, have remained patent and the circulation in the leg has been free from interference.

TREATMENT OF HAND INFECTIONS BY ACTIVE MOBILIZATION

Dr. Charles L. Gibson said that lessons taught by the war and particularly the renaissance of the ideas of Lucas Championniere and their very practical application by Willems to the surgery of purulent joints has probably made all surgeons seek to apply this method to other forms of suppuration.

Since 1918, he had sought to get early motion in hand infections; but the principle was developed in only a rather desultory manner until recently, since when it has been systematized. The practical problem was to give the patient sufficient freedom of hands and fingers under a suitable dressing. Definite progress was made when Dr. Clay Ray Murray took hold of the matter and encased these hands in an electric light bulb. (Fig. 1.) Hand and fingers could then be worked freely, the secretions being caught by suitable dressing surrounding the cage.

At present our method is an exact imitation of Willems' method: the making of suitable incisions, no packing, and no dressing is put on the hand.

It is simply confined in a cage and the patient is instructed, or better, made to flex and extend the fingers very frequently. Applied in this way the patient has a chance to exercise the hand before there is any stiffness to overcome, and it is surprising with what little pain this procedure can be carried out. The intelligent patients coöperate very readily. Per contra, if the patients are stupid or balky it had better not be tried.

All the patients treated in this way have finished with perfectly functionating hands and fingers, and with a minimum of atrophy of the muscles. The bulk of these patients have been healed up more quickly by this than by the older methods.

In illustration he presented the following patients:

Case I.—Male, age twenty-five, admitted February 1, discharged February 10, 1923. There was no history of trauma, the patient coming in for treatment of a cellulitis of the palmar space which he had first noticed ten days previously. There was progressive pain and swelling. The "sore spot" had been "opened" in the admitting room three days previous to admission. He was admitted with a painful, useless, red and swollen hand. There was a two-inch incision in the palm exuding pus, redness and swelling of the forearm with red streaks of lymphangitis of arm. Temperature 102°, pulse 88, respiration 22. The palm incision was extended one inch and into palmar space; thenar space was opened by incision back of web of thumb under ether anæsthesia. The cage was then applied.

Case II.—Male, admitted March 22, 1923, not yet discharged.

Five weeks before admission caught his hand on a nail going quite deeply into the palm of the left hand. Hand began to swell the next day. Incision four days later by outside physician over swelling in palm. Several subsequent incisions made at different times. Hand kept getting worse.

Patient admitted to the hospital March 22, 1923. Local condition: marked swelling over the hand extending to the wrist. On motion there was marked limitation of flexion and some limitation of extension with limitation of motion at the wrist joint.

Incisions made in centre of palm and over centre of wrist March 23. Cage applied.

Case III.—Woman, one week before admission noticed painful callous-like spot in palm of hand. Whole hand quickly became swollen. Three incisions (February 20, 21 and 24) made by outside physician. Condition became steadily worse.

Admitted February 26 with swelling of whole dorsum of hand, forearm and upper arm. Marked tenderness with restricted motion. Palmar and dorsal incisions February 26 under ether. Cage applied.

Discharged March 1, 1923.

Dr. Clarence A. McWilliams did not see how, if these were simple subcutaneous infections, mobilizations could materially increase the drainage. If, however, the sheaths were involved, motions of the contained

FIG. 1.—Infected hand enclosed in an electric light bulb.

tendons would undoubtedly facilitate external drainage through adequate incisions. Whether such motions would spread the infection further up and down the sheaths and thus act injuriously, further experience alone would tell. There probably would be no deleterious effect because drainage always occurs towards the place of decreased pressure, in this case through the incisions. The great advantage of these mobilizations lies in the lack of the necessity for gauze or rubber tissue or tube drains, hence one would expect less liability to tendon sloughs. If this revolutionary method of treating tendon infections should prove as successful as Willems' method of treating joint infections, it will indeed be a wonderful advance.

Dr. Walton Martin questioned whether the very excellent results in the cases shown were due to the active mobilization or to correctly placed incisions insuring proper drainage without gauze drainage. He felt sure that many of the bad results in the past had been due to the tissue damage done by improper gauze packing. He found it difficult to believe that there was any sound biological basis for the opinion that active mobilization of the tendon in the tendon sheath limited infection.

Doctor Gibson said that the cases he presented had been chosen at random; in two of the cases the tendon sheath was involved. Every patient treated by this method has done exceedingly well and has a good functioning hand. Results like these in infections of the hand are not very common.

COLECTOMY FOR CHRONIC INTESTINAL OBSTRUCTION

Dr. Walter A. Sherwood presented a woman, twenty-seven years of age and a graduate nurse by occupation, whose chief complaints were recurring attacks of indigestion, associated with vomiting, right-sided abdominal pain and increasingly obstinate constipation. These attacks had been increasing in frequency and severity for the past year.

In 1910, she was operated on for supposed appendicitis; the incision made at that time was small and apparently the abdomen was not explored. She was again subjected to operation at various hospitals in 1912, 1914, and 1919 for post-operative adhesions and symptoms of intestinal obstruction. She experienced temporary relief after each operation, but again became incapacitated on several occasions while on duty at the Brooklyn Hospital, because of severe attacks of abdominal pain accompanied with nausea and constipation.

A careful study of her condition was made and further surgical intervention was not advised until January of this year, when she grew progressively worse. When admitted for further observation she was having more or less constant pain and was extremely tender over the entire right side of the abdomen. Nausea and an inability to take food had resulted in a marked loss of weight together with body dehydration. A further gastrointestinal X-ray study showed evidence of obstruction in the low lying cæcum and ascending colon. Her condition was such that operative measures again seemed imperative, and after several days of forced fluid administration the abdomen was opened through a long right

rectus incision. There were no adhesions, bands or pericolic membranes, but there was a generalized visceroptosis, the stomach, cæcum and transverse colon being especially low in the pelvis.

The terminal ileum, entire cæcum and first third of the transverse colon were enormously dilated and entirely flaccid, producing a condition which was interpreted as chronic adynamic ileus. The findings and history of this patient seemed to warrant extreme measures for her relief, and it was therefore decided to remove that portion of the bowel which was involved in the pathology described. Six inches of the terminal ileum, the cæcum and ascending colon together with the first half of the transverse colon were resected and a side-to-side anastomosis was effected between the ileum and transverse colon, close to their resected ends. The operation was rendered simple by careful attention to the blood supply, the use of Payr clamps and the prevention of soiling by means of cautery resection with careful infolding of the ends of the bowels with three rows of chromic sutures.

All raw surfaces were peritonealized and the operation completed in the usual manner. Twenty-four hours after operation the patient went into severe secondary shock with rapid feeble heart action and very low blood pressure. This was associated also with frequent attacks of regurgitant vomiting, apparently the result of post-operative intestinal paresis and reverse peristalsis.

Syncope and hiccough, frequently repeated, added to the gravity of the condition, but continuous hypodermoclysis and frequently repeated gastric lavage resulted in a gradual improvement, and on the fifth day a normal fecal current was established, after which recovery was rapid and uneventful. The patient left the hospital at the end of three weeks in excellent condition and with a solidly healed wound. Now, at the end of two months, she is entirely free from all symptoms and is rapidly gaining in weight. She eats heartily, has no indigestion, nausea or pain, and for the first time in years is not in need of cathartic drugs.

Doctor Sherwood further observed that although the misapplication of this procedure has resulted in many disappointments and surgical failures, there is nevertheless a distinct group of cases in which the disability is so well marked and easily recognizable as to warrant the most radical measures for relief. It has been his experience that when properly selected for operation, patients suffering from extreme degrees of intestinal stasis with prolapsed cæcum or colon and a loss of muscle tonus sufficient to produce symptoms of chronic or intermittent obstruction, lend themselves well to the operation of colectomy and obtain marked or complete relief with much improvement in general health.

In his hands, attempts to anchor or fix the colon with sutures have not been permanently satisfactory, and it is his feeling that if surgical measures are at all indicated nothing short of the complete operation may be counted on to secure permanent relief.

ACUTE OBSTRUCTIVE DUODENAL ULCER

DOCTOR SHERWOOD presented the following cases:

CASE I.—A man, twenty-five years of age, who entered hospital because of severe upper abdominal pain of ten weeks' duration. He had no history of long continued digestive disturbance but one month before coming under observation he had been seized with generalized abdominal pain and vomiting. He has never vomited blood, but stated that his stools had been very dark in color.

Examination of the abdomen, which was tensely held, revealed nothing but tenderness on deep palpation in the epigastrium and the right lower quadrant. The laboratory tests, Ewald meal, and gastro-intestinal X-ray study were of no value in establishing a diagnosis. The clinical history was such, however, as to warrant the assumption of definite pathology, and on opening the abdomen there was found to be a well-marked acute ulcer on the anterior surface of the first portion of the duodenum. There were numerous adhesions and a red angry appearance of the tissues surrounding the ulcer together with œdema and swelling sufficient to produce pyloric obstruction.

Radical extirpation of the acutely inflamed ulcer area seemed unwise and a simple posterior no loop gastrojejunostomy was done together with a removal of the appendix which was definitely infected. Recovery of this patient was rapid and uneventful, and he has obtained complete relief from all symptoms. He reports that he is gaining rapidly in weight and has no discomfort of any kind.

CASE II.—The second case is a man, sixty-eight years of age, who was well until nine months before entry into the hospital. He then began to have distress after eating, associated with eructations of gas. These symptoms persisted with increasing severity, and for the past three months he has had sharp pain in the upper abdomen without reference to meals, increasing constipation and much prostration. For three weeks previous to admission to the hospital he had complete anorexia, vomited frequently and passed blood in his stools. He lost about forty pounds in weight and was greatly annoyed by persistent hiccough.

Examination on admission revealed an elderly man, much emaciated and apparently very ill. The physical findings were irrelevant except for tenderness in the right hypochondrium and the suspicion of a tumor in the region of the pylorus. Hæmoglobin 60 per cent., blood examination and cell count otherwise negative. Test meal showed almost complete absence of free hydrochloric acid and only 2 c.c. of total acids after 80 minutes.

There was much occult blood found in several stool examinations. The entire clinical picture and history presented in this case were highly suggestive of malignant disease, and such a diagnosis was made previous to operation, although the X-ray study in this case was in no way suggestive of gastric carcinoma, a study of all films being diagnostic of obstructing duodenal ulcer and so reported by the röntgenologist, Dr. Ruth Ingraham.

At operation a small semi-solid tumor was found involving the first portion of the duodenum and almost completely obstructing the pyloric outlet.

On careful examination, this mass was found to be a large soft ulcer, surrounded by inflammatory exudate. It was in no way suggestive of carcinoma and there were no glandular enlargements.

Here again, it was considered unwise to subject this patient to a radical excision of the ulcer and a simple posterior no loop gastro-jejunostomy was done in the usual manner. The appendix which was pathological was also removed. The patient made a prompt and uneventful recovery and has experienced complete relief from all symptoms. He is gaining in weight rapidly, and it is evident that the obstructive process was the principal factor in the production of his most serious symptoms.

Doctor Sherwood further remarked that the present tendency to excise or to do some type of pyloroplasty or extensive resection of ulcer bearing areas has an increasing number of advocates. It may be admitted that this principle is sound in the chronic indurated and non-obstructive ulcers, particularly those which involve or deform any portion of the stomach, and in which the later development of malignancy may be a factor.

In obstructive ulcers, however, which involve only the first portion of the duodenum, as in the two cases reported, where malignancy very seldom or never occurs, he was still of the opinion that simple posterior gastroenterostomy is a highly satisfactory procedure and is followed in most instances by complete and permanent relief. It is also his practice in such cases to remove the appendix and to take care of coexisting pathology in the gall-bladder; factors of undoubted importance in the etiology and continued or post-operative activation of ulcer symptoms.

HEALED TROPHIC ULCER OF AMPUTATION STUMP FOLLOWING PERI-ARTERIAL DECORTICATION

The detailed report of this case is embodied in the paper of the evening, for which see page 321.

EXCISION OF ADVENTITIA OF BRACHIAL ARTERY (LERICHE OPERATION) FOR RAYNAUD'S DISEASE

Dr. Harold Neuhof presented a woman, forty-one years old, who came under observation on the First Surgical Division, Bellevue Hospital, in July, 1922, with a typical history and clinical picture of Raynaud's disease in the upper extremities.

In her previous history the salient features are the use of coffee and cigarettes in great excess, alcohol in moderate excess. Menstruation ceased at the age of twenty-six. Five months before she was admitted, the symptoms began in both hands, consisting in attacks of coldness and numbness in the finger tips which became dead white for varying intervals. Following the period of pallor the fingers would become purple

and exquisitely sensitive. These manifestations soon ceased in the left hand but continued and became progressively more severe in the right. Gangrene of the index finger of the right hand developed and was progressive.

Physical examination revealed no evidence of arteriosclerosis, but the left radial pulse could not be felt. Pulsation of the vessels in the right upper extremity was normal. There were spots of necrosis at the tips of several fingers and gangrene of the distal portion of the right index finger. During the period of observation before operation the patient suffered severely with pain in the right hand coming on at frequent intervals, during which time ischæmic manifestations were noted.

Amputation of the finger was clearly indicated, but it was also evident that this would not relieve the severe pain and circulatory disturbances in the right hand and that repair of the amputation stump would not be good because of the poor circulation. It was therefore decided to operate according to Leriche first, and to amputate at a later sitting.

At the operation on the brachial artery the adventitia was removed for a length of about 7 cm. No constriction or dilatation of the artery was observed. The pulse was present at the wrist directly after operation. Relief of pain in the hand began within twenty-four hours and the patient remained free from manifestations of circulatory disturbances. The pain about the gangrenous finger persisted, however, and amputation was done about two weeks after the Leriche operation. The amputation stump healed by primary union. It is now eight months since the operation and patient has remained entirely free from pain and circulatory disturbances in the right hand. The circulation is good and has not been otherwise even in cold weather, or in the occupation of the patient involving immersion in cold water upon frequent occasions.

THE RELATION OF SURGERY TO CERTAIN DISTURBANCES OF THE VASCULAR SYMPATHETIC SYSTEM

Dr. Walter A. Sherwood read a paper with the above title, for which see page 321.

Dr. DeWitt Stetten said that he had attempted the Leriche operation in two cases of thrombo-angiitis obliterans which, however, he did not regard as an ideal indication for the operation. The first patient had a gangrene of the first, second and third toes of the left foot, redness and œdema of the foot and very severe pain. There was a good popliteal pulse. The femoral artery was exposed in Hunter's canal and about 8 cm. of the adventitia was excised. For three days there was no improvement, but after that the pain markedly diminished and the redness and œdema of the foot subsided considerably. The patient had been unable to sleep without sedatives and now managed to get a good night's rest without drugs of any kind. The gangrenous portions of the toes were then removed. The wounds at present are clean and show a healthy granulating surface, but recently the pain has recurred, although not quite as severely as before the peri-arterial sympathectomy. The second patient had a

gangrene of the fifth toe of the right foot. There was no popliteal pulse. Doctor Stetten attempted to expose the artery in Hunter's canal and found it imbedded in dense inflammatory cicatricial tissue, so that it was dissected out and separated from the vein with great difficulty. The artery was not pulsating, and on palpation, it was noted that a blood-clot broke up under the examining finger. With an assistant controlling the hemorrhage by digital pressure on the femoral pulse in Scarpa's triangle, a longitudinal arteriotomy was done. Part of the clot was extracted with forceps and the balance was irrigated out with saline solution or, loosened with a probe, it was allowed to shoot out with the blood stream by having the assistant release his finger from the vessel above. After the vessel had been cleaned upward as far as the groin and downward as far as the popliteal region, arterial blood was allowed to flow for a while, and then a Carrel suture of the artery was performed. It was obviously impossible to excise the adventitia. The artery was pulsating very well, as the superficial wound was closed. The patient was much improved in spite of the fact that the popliteal pulse could never be felt after the removal of the thrombus. Later the gangrenous toe was removed and the patient is now relatively comfortable, although it is possible that at least a portion of the vessel has been re-occluded.

Dr. Hermann Fischer spoke of having had a similar experience to that of Doctor Stetten. His patient was suffering from arteriosclerotic gangrene of the second and third toes of his right foot. He was treated for several weeks with large doses of Ringer's solution (6 to 8 litres in 24 hours) which was introduced into the duodenum by the duodenal tube. As this treatment had no influence at all on the pain or the lesion, it was decided to give Leriche's operation a trial. The effect of the operation, however, was nil, and an amputation finally became necessary.

Dr. John A. Hartwell said he had done the Leriche operation four times on three individuals. The first time was in the case of an old man with marked arterial changes. Circulation of the left lower extremity was so compressed that there had resulted a condition markedly similar to an ischæmic paralysis. A marked equinovarus had followed this, and there was a large pressure ulcer over the external malleolus. The entire leg and foot had the appearance of a cadaver, though no gangrene was present. No pulsation could be found in the vessels around the foot, though it was thought to be present in the popliteal artery. Amputation was done above the knee. Healing was prompt but there developed an exceedingly painful stump, without apparent cause. The pain was spontaneous and had nothing to do with pressure. He was admitted to the hospital several times for this condition, and finally about five months after the amputation a sympathectomy was done upon the lower external iliac and the common femoral artery. The superficial femoral artery, below the point where the profunda was given off, had no pulsation and seemed to be completely thrombosed. The profunda artery seemed to be the only source of circulation to the extremity. The Leriche operation was done in the typical

way for a distance of about three and one-half inches of the iliac and common femoral. Pulsation in the artery following the procedure seemed to be greatly reduced, but its lumen did not seem to become narrower. There was some question, therefore, as to whether Leriche's instructions had been fully carried out. He states that when all the sympathetic fibres are removed there will follow a very definite narrowing of the artery. Subsequent events have proved that the pain has been almost completely relieved. Sympathectomy was done nearly a year ago, and the patient has had only one attack of pain which occurred during the excessive cold of the past winter, and was completely relieved by a few days' rest in bed. The second patient was a Hebrew, aged forty-five years. He had had his left thigh amputated a year previous for what was presumably thrombo-angiitis obliterans, the symptoms of which had been present for three years. The stump, however, healed normally, and was without pain. The condition in his remaining foot was of short duration. He had some pain, but never serious until three days previously. There had rapidly developed a distal gangrene on the little toe of the right foot, and the great toe was distinctly purplish and tender. He was kept under observation for one month, during which time there had been some increase of the gangrene, with a great deal of severe pain. There was pulsation in the popliteal artery, but none could be felt in the ankle. The little toe was disarticulated at the metatarsal joint. One week later a sympathectomy was performed upon the common and superficial femoral arteries for a distance of about five inches. In this case there was a full contraction of the artery as indicated by Leriche as proving that the operation was correctly performed. Patient was discharged with the amputation stump healthily granulating, and he stated that the pain in the foot was decidedly lessened. Reported by letter to the follow-up clinic two months later that he was free from pain and that circulation in the foot seemed greatly improved.

The third patient was an Englishman, aged forty-seven years. There was no evidence that he had syphilis. Symptoms in his condition, however, represented those of an arterial sclerosis, though the type of pain and the slow development of the symptoms were more those of the thrombo-angiitis obliterans. When admitted to the hospital he had gangrene of the left foot, for which an amputation was done in the leg. Severe infection resulted and a second amputation had to be done in the thigh. At this time he was having very considerable pain and poor circulation in the other foot. A double sympathectomy was done upon him on October 24, 1922, at which time the stump was unhealed. Following this operation healing took place very kindly, and after a period of about six weeks he was entirely free from pain in the other extremity. He was seen at the follow-up clinic five months following the operation, when he had no pain whatever. Circulation in the foot seemed excellent, and the stump at the site of the amputation was healthy and soft. In this case the artery contracted to about one-half its normal size immediately on removing the adventitia.

The speaker's experience with these cases makes him believe that some benefit may be derived from this operation, both in cases of arterial sclerosis and in cases of thrombo-angiïtis obliterans. If such prove to be the case it must be that the greater volume of blood allowed to enter the distal vessels overcomes the pathology which is threatening the life of the tissues.

Doctor Neuhof said that he considered it difficult to understand how the Leriche operation could be of advantage in thrombo-angiïtis obliterans. His own experience had been disastrous, the patient developing gangrene after operation, requiring immediate amputation. It was of interest to report that in a patient with advanced arteriosclerosis and severe pain in the lower extremities operated upon in Bellevue Hospital, great relief followed the Leriche operation on the femoral artery on the right side, whereas relatively little relief from pain was the sequel of the identical procedure on the left femoral artery. The pathology of the vessels was the same on both sides.

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